

E-Learning Tools, Techniques and Applications

Helmholtz-Zentrum Potsdam

Deutsches GeoForschungsZentrum GFZ, Potsdam, Germany

June 17 - 19, 2009



Hosted and organized by

- Institute of Geodesy and Geoinformation Science, Technische Universität Berlin
- Newcastle University, CEG, Newcastle University, Newcastle Upon Tyne, UK
- Deutsches GeoForschungsZentrum GFZ, Potsdam
- Deutsche Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation (DGPF)

The Workshop is combined with the meeting 5. GIS - Ausbildungstagung organized by
Deutscher Dachverband für Geoinformation e.V. (DDGI)

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BEST PRACTICE IN E-LEARNING: APPLICATIONS IN PHOTOGRAMMETRY, REMOTE SENSING AND GIS

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KEY WORDS: Teaching, online, design, development, requirements

ABSTRACT:

This article reports on best practice e-learning applications in Photogrammetry, Remote Sensing and GIS. The rating is based, on results of the Computer Assisted Teaching CONtest (CATCON), a competition organised by ISPRS WG VI/2 that takes place every two years, on observation of recent developments, and on the short-term project “Analysis of e-learning Software and Guidelines for Quality Assurance”. In this study, which was supported by the ISPRS foundation, experts from the related disciplines were asked to evaluate 30 e-learning products. Although social interaction and interactive participation are key indicators for success in online learning many tools don’t make use of these techniques. As e-learning will play an even more important role in near future, valuable and sustainable tools must be identified, which follow active learning approaches including collaborative exercises and short feedback loops.

This contribution gives practical support for quick reference to first choice e-learning material – not only for university students, but also for primary and high school students. Moreover, consideration of these resources will include a commentary on trends in e-learning and future prospects for further development.

1. INTRODUCTION

As a result of the continuing global economic crisis e-learning will gain more interest and importance. Companies will increasingly make use of online training to avoid additional travelling expenses. Also employees have recognised the needs for professional training in order to keep pace with the rapid development in the fields of photogrammetry, remote sensing and GIS. But beyond the cost factor the quality of life-long learning offers will be essential for the acceptance of e-learning material.

Up to now only few products in photogrammetry, remote sensing and GIS have made an attempt to evaluate the learning materials. This makes a potential user feel uncertain which modules are worth studying.

To overcome this situation, ISPRS supports the Computer Assisted Teaching CONtest (CATCON), which takes place every second year, on the occasion of ISPRS congresses and Commission VI symposia. Certificates and monetary prizes, supported by the ISPRS Foundation - Gold, Silver, and Bronze Award (2008: US\$ 1,000; 750, and 500) - are awarded to the three submissions that are judged to be the most innovative.

Moreover, ISPRS funded the short-term project *Analysis of E-Learning Software and Guidelines for Quality Assurance in Photogrammetry, Remote Sensing and GIS* to lay the foundations for evaluating e-learning software. It further gives help to potential users to identify appropriate applications and give recommendations for most suitable material. The project work included the definition of criteria by which e-learning applications should be evaluated and an online questionnaire for reviewing e-learning software.

2. QUALITY EVALUATION

The results of the short-term project, in particular the discussion of 42 criteria for quality evaluation of e-learning material is documented in Katterfeld & König (2008). The criteria emphasized educational aspects, didactics, design, curricular integration and portability. Based on this criteria catalogue a representative selection of 30 English-language e-learning products were reviewed by experts from the related disciplines.

In summary the following issues have been identified:

- Since many criteria in the didactic section only reach average or poor values, the lack of didactical concepts must be mentioned. Hence a more intense occupation with didactics is required. Investments in concepts, elaborated design of instructions and implementation of feedback is crucial.
- Consideration of learning context is generally underestimated. More differentiations within the material would be helpful to suit diverse learning needs. Aspects also important in the didactic section would help to better focus on the learner, such as user-dependent availability of material, exercises and tests, options for individual assessment or individual support.
- Implementation and establishment of metadata information based on international standards is rarely used which prevents an easy data exchange and counteracts interoperability.

The three issues mentioned above are not new. However for the current moment the study identified them as focal points for future development and improvement in e-learning.

The results of the review can be accessed at the webpage of Commission VI / WG 2 (cf. figure 1).



Figure 1: Review results for Remote Sensing education modules

<http://www.igg.tu-berlin.de/index.php?id=1624>

However the authors are aware of the subjectivity of such personal review. Hence the online questionnaire (<http://www.igg.tu-berlin.de/ISPRS/quality/questionnaire.php>) is still open for public evaluation.

3. CLASSIFICATION OF WEB-BASED LEARNING MATERIAL

In general several types of educational material can be distinguished:

- Textbooks enriched by images and (animated) graphics. This type is represented by the first generation e-learning stuff, such as the Remote Sensing Core Curriculum (RSCC) <http://www.r-s-c-c.org/>, which was originally developed under the frame work of the American Society for Photogrammetry and Remote Sensing (ASPRS). Today, the newly formed International Center for Remote Sensing Education (ICRSEdu), a non-profit corporation, is responsible for managing the RSCC materials. (<http://www.icrsed.org/>).
- Interactive textbooks, such as the e-learning products of the Canadian Centre of Remote Sensing (CCRS). CCRS provides several interactive training modules mainly focussing on remote sensing. Each tutorial is characterised by rich images, graphics and animations. Quiz tests at the end of most tutorials allow self-guided assessments (http://ccrs.nrcan.gc.ca/resource/index_e.php#tutor).
- Web based Powerpoint scripts, often stored as pdf-document, which can be found in nearly every university. The slides are mainly distributed as additional teaching aids and used by students for reinforcing lectures topics. Depending on the quality, slides include valuable comments for a better understanding. A good example explaining relational databases can be found here (in German language only): <http://www.sws.bfh.ch/~schmd/db/SKRIPTE/Relationale-Datenbanken.pdf>
- Next generation material was influenced by the appearance of web-based Learning Management Systems (LMS). As a result, organisation of online courses, distribution of learning

content and the realisation of instructor-led training were easy to handle. Moreover, tools for application sharing, chats, discussion threads etc. allow new didactical concepts, grouped under the umbrella term *collaborative learning*. LMS are widely used in universities, educational institutions, and also accepted in the industry.

- With the increase of network bandwidth, a new type of online material emerged: lectures could now be recorded, synchronized with Powerpoint slides and distributed as Video on demand courses over the Internet. Nowadays lectures are more and more distributed by podcast. Students have the advantage of taking classes anytime anywhere, learning at their own pace. These techniques are used for global courses (JICA NET, EDUServ).
- Caused by the fact that current educational methods are not engaging students enough, game-based strategies are introduced for content development. Students are now at the centre of the learning experience, which requires active participation and interaction. Reports of how game-based strategies can be used in our fields are found in Balz.& Fritsch (2008).

In the following chapter a selection of best practice web-based learning material is given. This short overview not only focuses on high-education course material, but also includes stuff for kids and teens.

4. BEST PRACTICE EXAMPLES

The following examples of best practice use various forms of digital media and interaction. Each of these examples exhibits one or more exemplary features. They should inform of existing media-supported applications in education and help to develop own ideas for teaching applications. Of course there is much more valuable e-learning material available that could not be mentioned here. Other prominent learning content described in former reports – König, Schiewe (2006) and König et al. (2008) – is not part of this paper.

4.1 Web pages for primary and high school students related to Geodesy, Remote Sensing, and GIS

This example section is related to content valuable for kids. The main objective is to captivate children at an early age in Earth science through multimedia adventures. But the web pages are also of interest for adults, since they represent game based and collaborative techniques.

4.1.1 ESA kids

The European Space Agency (ESA) guides children through the virtual universe. Space related topics are in the focus and kids find lots of information and answers on nearly every question. A variety of remote sensing applications is presented emphasizing the important role the technique plays for environmental monitoring. A nice animation explains the Sun-synchronous orbit of Earth observation satellites. The web page is very varied, including a lab for practical work, pages containing games and quizzes. Given information and news are up-to-date, as seen in figure 2 containing multiple choice question on, ESA's first Earth Explorer GOCE (Gravity field and steady-state Ocean Circulation Explorer), which was launched three month ago.



Figure 2: esa kids web page: GOCE quiz

http://www.esa.int/esaKIDSen/SEM4NWP4KKF_q.html

4.1.2 NASA – IMAGERS

NASA's IMAGERS (Interactive Multimedia Adventures for Grade School Education Using Remote Sensing) Program also addresses children and schools.

Two well-designed multimedia adventures *Adventures of Echo the Bat* and *Adventures of Amelia the Pigeon* try to captivate children at an early age in Earth science through multimedia games. Besides the interactive web sites telling the story, supplemental material is offered for parents and teachers enabling them to impart knowledge on Earth science using remote sensing imagery via identification of land use, exploration of featured habitats, and changes in the environment. Basic technical terms (e.g. electromagnetic spectrum) and fundamental concepts are explained most suitable for kids.



Figure 3: Welcome page of NASA's IMAGERS program

<http://science.hq.nasa.gov/kids/imagers/index.html>

4.1.3 EARTH EXPLORATION TOOLBOX (EET)

The Earth Exploration Toolbox, funded by the National Science Foundation (NSF) consists of a huge collection of learning instructions based on Earth science datasets. The Technical Educational Research Centers (TERC) working in partnership with several colleges and universities, promotes curricula and materials development. The material offered under a Creative Commons license (Attribution-NonCommercial-ShareAlike 1.0) is free for non-commercial use.

Input data originates from the science and education program GLOBE (Global Learning and Observations to Benefit the Environment), which started in 1995. GLOBE supports an international collaboration of schools, which collect data for monitoring the dynamics of the Earth's environment. Today, more than 20000 schools around the world are engaged in the international GLOBE network, they have contributed more than 19 million measurements to the GLOBE database.

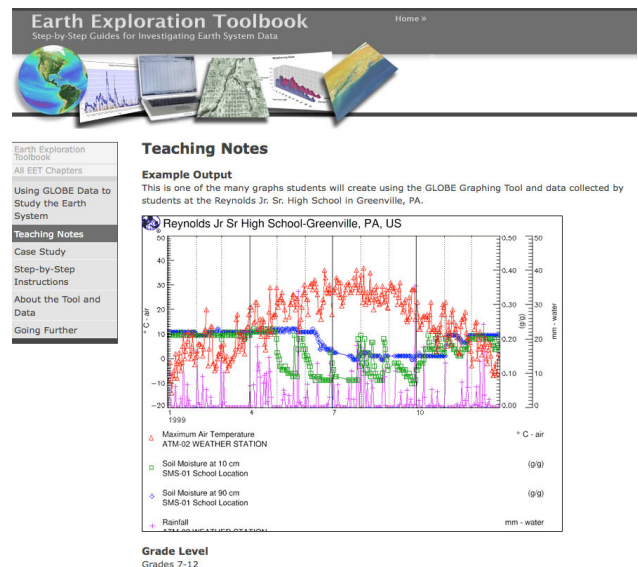


Figure 4: Teaching notes distributed by EET

http://serc.carleton.edu/eet/globe/teaching_notes.html

Worldwide temperature measurements as seen in figure 4 allow comparing the situation in different regions and help to understand how climate changes.

4.2 E-Learning material for university students

4.2.1 CCRS - IMAGE INTERPRETATION QUIZ

The Canadian Centre of Remote Sensing (CCRS) provides a variety of interactive training modules mainly focused on remote sensing (fundamentals, digital analysis techniques, radar etc.). http://ccrs.nrcan.gc.ca/resource/index_e.php#tutor. Each tutorial is characterised by rich images, graphics, and animations. A print version is also available. Quiz tests at the end of the most tutorials allow a good self-control.

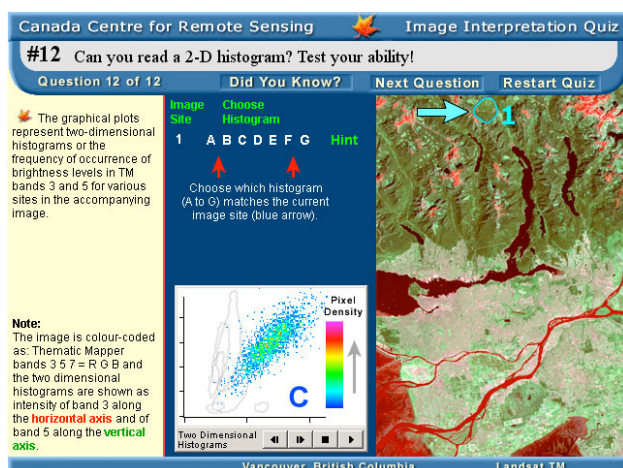


Figure 5: Image Interpretation Quiz (CCRS)

http://ccrs.nrcan.gc.ca/resource/tutor/iquiz/interactive/start_e.php

Of special interest is the interactive Image Interpretation Quiz that is designed for students who would like to explore a variety of interpretation techniques and concepts. The interactive version requires installation of the free Shockwave plug-in. Topics include:

- Feature recognition;
- Band combination colour assignments;
- Image enhancements;
- One and two dimensional histograms; and
- Airphoto / satellite image comparison

In general CCRS tutorials are of high quality and can be recommended without reservations.

4.2.2 3.1 RS-FUN, GT-SIMULATOR

A kind of role game based approach was used for the development of material designed at the Tokai University in Tokyo: RS-Fun and GT-Simulator. Both tutorials help for a better understanding of remote sensing technologies. The course content is especially suited for high school or lower grade students. While RS-Fun focuses on basic concepts of remote sensing (Cho et al. 2007), students can gain knowledge about the basic idea of ground truth spectral measurement by using the Flash based GT-Simulator.

After learning about the spectral reflectance measurement with GT-Simulator, the time required for them to understand the operation of spectrometer at the practical ground truth training was much reduced compared to the students who did not use GT-Simulator in advance.

The recent version of the GT-Simulator can be accessed at the following site:

<http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/GT-Simulator>.

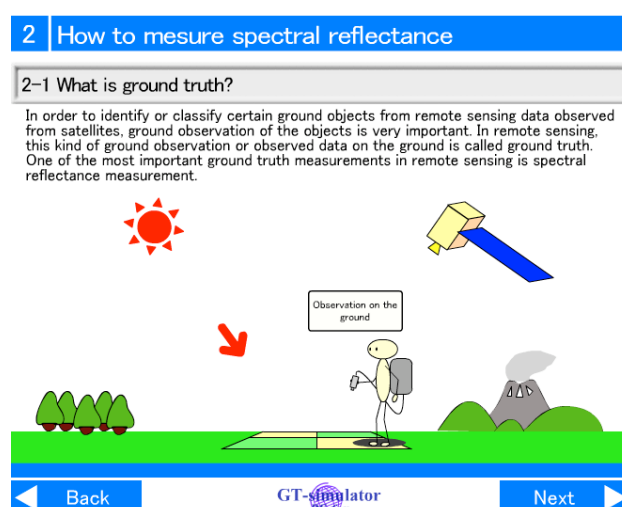


Figure 6: Animated web page illustrating ground truth measurements

4.2.3 INTRODUCTION TO GIS

Introduction to GIS is a self-learning tool developed at the University of Melbourne, Australia. The modules are addressed to students participating in Geographic Information Systems (GIS) courses. It is recommended to work through all parts in a predefined, sequential order.

The modules show a homogeneous structure: after explaining theory and concepts, interactive examples in realistic scenarios help for a better understanding. This is followed by test questions, which require the student to apply knowledge learnt in the related sections.

A glossary and list of references complete the learning material.

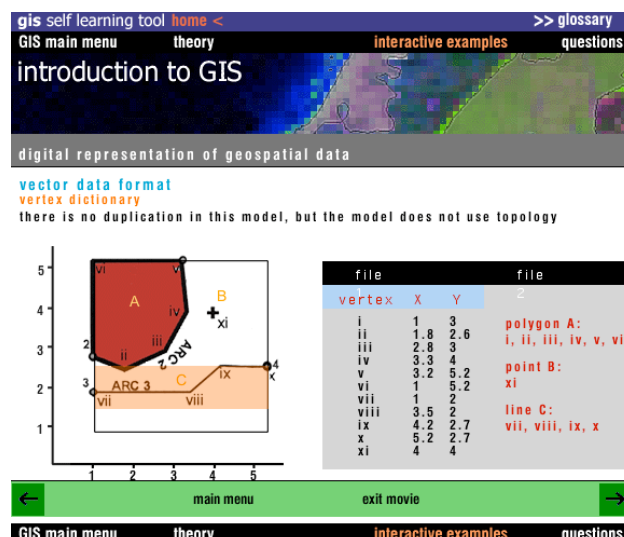


Figure 7: Webpage explaining representation of vector data in a GIS

<http://www.sli.unimelb.edu.au/gisweb/GISModule/GISinteractive.htm>

4.2.4 FERGI+

During the last two years a variety of e-learning modules have been produced and evaluated by the project partner of the University of Osnabrück and the Universities of Applied Sciences in Oldenburg and Osnabrück (Grendus et al., 2009). The content is offered to students as additional information to lectures but also open to the public during an eight-week free access period. Moreover, certificates are given to participants of small and medium-sized enterprises who take part in a 6-month in-service training available for a fee. Modules are mainly provided in German and partly in English. Content development is based on HTML, CSS, JavaScript, PHP and Flash. For an overview on the courses see <http://www.fergi-online.de>.

Figure 8: Methods for image fusion illustrated in Fergi+

<http://www.fergi.uni-osnabrueck.de/moodle/mod/resource/view.php?id=1201>

4.2.5 WEBGEO

The learning portal WEBGEO (Webbing of Geoprocesses) had its origin in a joint research project with the participation of 8 universities in Germany. Topics are structured into four parts: WEBGEO basics (ranging from climatology to geomorphology to remote sensing and more), WEBGEO regional (puts emphasis on regional areas), WEBGEO applied (continulative and detailed topics beyond basic geography) are taught in German language. WEBGEO English offers basic learning modules to international students. All modules, enriched with multimedia elements include test questions, are of high quality.

A further English training course (to be found in WEBGEO applied) was developed to assist the Department of Agricultural Extension (DAE) of the Government of Bangladesh to better understand the concepts and implementation of climate and flood forecast applications. (see fig. 9).

Figure 9: WEBGEO project web page

<http://www.webgeo.de/module/applied/FAO/probabilisticforecasts-bgd-fao.html>

2005 WEBGEO was nominated to the *Medida-Prix* and has won the *European E-Learning Award* in 2006.

4.2.6 TU BERLIN - CityGML

City Geography Markup Language (CityGML) is an OpenGIS® Encoding Standard for the representation, storage and exchange of virtual 3D city and landscape models. The initiative to setup an e-learning course on CityGML was pushed by the EuroSDR committee who decided to offer online training courses. Now, after the successful run during the sixth and seventh round of annual courses the e-learning modules are available for free use.

In order to offer participants the possibility to consolidate their knowledge, lectures based on MS PowerPoint slides are recorded, stored in Adobe Flash format and open for continuously repetition during the follow-up work. Using an Internet browser with Flash plugin enabled allows participants to view the live video stream of the teacher giving his speech, along with synchronized images of his presentation slides and all the annotations and comments.

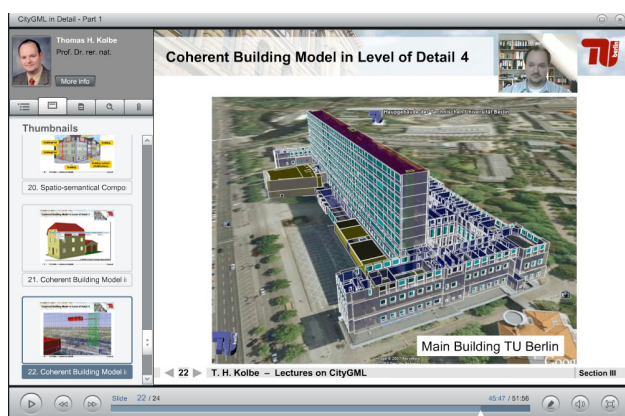


Figure 10: 3D building representation based on the CityGML standard

<http://www.igg.tu-berlin.de/courses>

The course content is structured in several lectures and exercises. Every chapter is enriched with a lecture-on-demand module. Required test data and relevant publications are offered for (free) download. Links provide access to further information and software that is needed for the exercises. In order to connect the participants, discussion board threading, wiki and real time textual chat, are open for use.

4.2.7 INTERMAP

Intermap Technologies™ is a digital mapping company creating digital elevation models, orthorectified radar images, and numerous value-added products based on its proprietary airborne Interferometric Synthetic Aperture Radar (IFSAR) technology.

To learn more about the fundamentals on IFSAR systems, Intermap has put a free course on Digital Elevation Models from IFSAR on the Internet. Audio supported slides enriched with Flash multimedia elements allow for a deeper understanding. Questions and a final quiz allow checking that what has been taught has actually been taken in by the student.

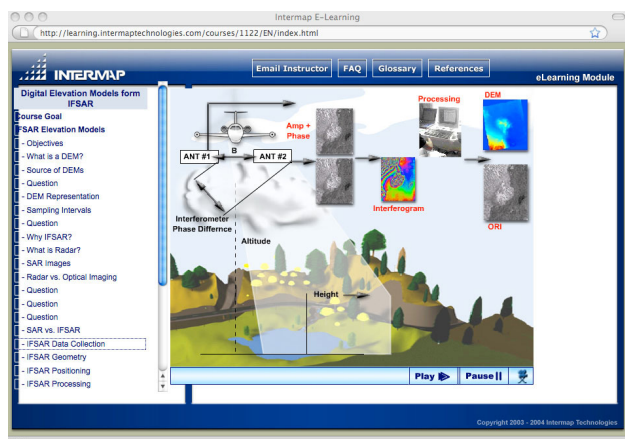


Figure 11: IFSAR data collection principle

<http://learning.intermaptechnologies.com/courses/1122/EN/index.html>

Moreover, Intermaps Resource Center offers a wide range of additional material. Beside advertising information, sample data, white papers etc. the user can download archived webinar recordings (<http://www.intermap.com/right.php/pid/1/sid/476>).

4.3 E-Learning material for software training

4.3.1 ESRI



Figure 12: Welcome page to ESRI's training program

<http://training.esri.com/gateway/index.cfm>

ESRI has been one of the first companies that recognized the significance of online training at an early stage. Since 1998, ESRI Virtual Campus offers self-paced training over the Internet. All universities or institutions participating in the ESRI Site License Program get unlimited-seat access for using these modules. Depending on the license agreement with ESRI, users are entitled to have free access. The web courses cover a wide range of topics related to ESRI software, the application of GIS, and the theory behind GIS technology. Courses take between 3-20 hours to complete. Registered users have up to one year to complete them.

5. RECENT AND FUTURE TRENDS

There are several clear trends in the development of e-learning material that are evident from progress made during the last two decades.

Internet delivery is increasing as bandwidth limitations diminish. This allows the usage of reliable techniques for transmitting streaming media to distribute content to many simultaneous listeners and viewers. To publish complete lectures via the Internet only non-interactive linear communication is necessary (*webcasting*). The ability to webcast content with a cheap and easy accessible technology is applied successfully especially in India in order to enhance the quality of engineering education in the country by developing curriculum based video. Within the framework of the *National Programme on Technology – Enhanced Learning (NPTEL)*, a joint venture by seven Indian Institutes of Technology and the Institute of Science Bangalore, supplementary content for 129 web courses in engineering/science and humanities have been developed in the first phase of the project. In addition, 110 courses have been developed in video format, with each course comprising of approximately 40 or more one-hour lectures. The lectures are distributed via YouTube as video sharing website. Of special interest are courses in Mathematics and Computer Science (<http://npTEL.iitm.ac.in/>). Lectures for example are focussing on Digital Image Processing and Remote Sensing in Engineering Geology.

Also distributed via YouTube is a short video explaining GPS tools, recorded at the Abu Dhabi Men's College (see figure 13).



Figure 13: YouTube lecture video

<http://www.youtube.com/watch?v=0xNfmfG1OOg>

With the success of Apples *iPod* free educational podcasts for teaching and learning are widespread. *iTunes U* was created as special service for colleges and universities in order to manage, distribute, and control access to educational audio and video content. The online service is without cost to those uploading or downloading material. In contrast to traditional podcasting access to content can be restricted in iTunes U, so that only students enrolled in a specific class are allowed to use this podcast.

According to the statement of Apple more than 150,000 lectures, presentations, videos, readings, and podcasts from all over the world are available for free. Students can access iTunes U content directly on their iPhone and iPod touch over both cellular and Wi-Fi networks through the iTunes Store.

Usage of podcasts in photogrammetry, remote sensing, and GIS is not widespread yet. A report on podcasting photogrammetry is given in Fritsch (2007).

Most enterprise professionals (ESRI, Erdas, Trimble, Fugro, Intermap, Oracle ...) recognize that virtual events are becoming an integral part of their marketing and communication toolbox (see fig. 14). Training of software skills or presentations of new products are often organised as *webinars*. Again communication is typically one-way, but unlike webcasts limited participation between the audience and the presenter is possible. This includes polling and question & answer sessions. In general, these webinars are archived for later access to everybody.

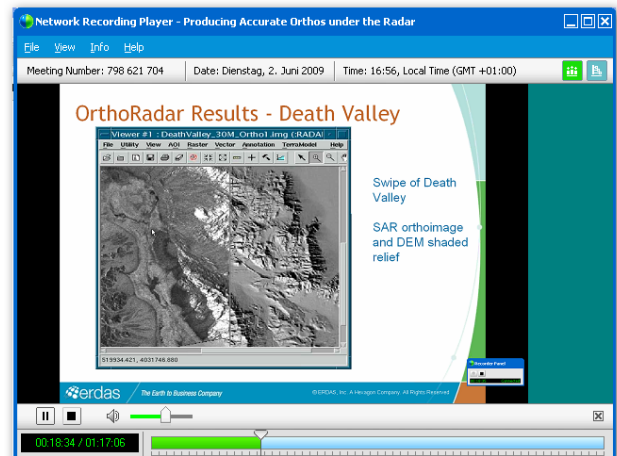


Figure 14: Erdas Webinar on Orthophoto Production

<http://www.erdas.com/Company/Webinars/tabid/91/Default.aspx>

Curriculum material is becoming richer and more detailed because of improved development tools, more powerful computers and the wider availability of source materials such as high-resolution images. E-learning material is becoming more and more interactive to increase engagement with the user and improve the effectiveness and depth of learning.

As the new generations of students assimilate the ubiquitous new media and Internet technologies, demand for communication and collaborative work will rapidly increase. Software tools for discussion forums, wikis and blogs are now part of most learning management systems. Students, in addition to teachers, will contribute to the learning experience and process.

Moreover, students' desire to play can be used for a digital game based learning approach. Serious games developed for training and education build on the young people's experience with computer games and may help to drastically increase the students' motivation and improve the learning success for a fast and sustainable learning effect. It is also clear that all these trends will continue and the use of immersive environments such as Second Life will expand rapidly in near future.

6. CONCLUSIONS

This paper has reviewed several specific examples of different types of online learning content illustrating the state of the art in e-learning, with a particular emphasis on geography, photogrammetry, remote sensing and GIS. E-learning has made, and will continue to make, an extremely valuable contribution to teaching and learning within the discipline at all levels of education and training. Trends toward the predominance of convenient Internet delivery, greater richness of the content, enhanced user-centred learning and the availability of effective quality evaluations will ensure the expanded use of e-learning in the future.

Since content development is growing rapidly, it becomes more difficult to remain focussed in the continuous change. A solution to keep track may be the installation of an e-learning wiki in our fields. International cooperation and partnerships in education will help to get knowledge about new developments and will be open for integration or exchange of learning material for sharing and re-use.

Another important aspect of e-learning material that will become increasingly important in the future is the quality of the resources provided. As with all web-based information, access is rarely guided by the quality of the information available on a web site, but more frequently by the popularity of the site or proactive manipulation of search engines by the organisation. A number of different approaches are possible to determine quality indicators, such as the reputation of the site or organisation, the number of citations of the material or an objective evaluation by professional reviewers. However, there is an emerging trend for Internet sites to be reviewed, either anonymously or by invitation.

7. ACKNOWLEDGMENTS

The author gratefully acknowledges the submissions from contestants in the CATCON competitions held at ISPRS conferences during 1996-2008 and acknowledge copyright of views of the material used in the figures.

8. REFERENCES

- Balz, T., Fritsch, D., 2008: High-Performance SAR Simulation on Retail Video Gaming Consoles for Education and Training Purposes, *Int. Arch. of Photogrammetry, Remote Sensing and Spatial Information Science*, 37(B6a): 213-219.
- Cho, K., Chujo, T., Tada, T., Shimoda, H., 2008. Strategic Approach for Sharing Educational Materials on Remote Sensing. *Int. Arch. of Photogrammetry, Remote Sensing and Spatial Information Science*, 37(B6a): 65-72.
- Cho, K., Komaki, A., Shimoda, H., 2007. Development of GT-Simulator for Remote Sensing Education. *Proceeding of MJISAT2007*, 12-15th November, 2007: 1-6.
- Fritsch, D., 2007. Podcasting Photogrammetry – A Contribution to Life-Long Learning. *Photogrammetric Week '07*, Wichmann, Heidelberg: pp. 335-344.
- Grendus, B., 2008. FerGI@KMU: Berufliche, zertifizierte Weiterbildung mit E-Learning-Modulen zur Geoinformatik. *Proceedings of the logOS 2008 „Lernen, Organisation, Gesellschaft - Das eCampus-Symposium der Osnabrücker Hochschulen“*, Osnabrück, Germany, pp. 19-23.
- König, G.; Schiewe, J., 2006. E-Learning courses for GIS and Remote Sensing in Germany: Status and perspectives. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science*, 36(6):.
- Katterfeld, C., König, G. 2008. Analysis of e-learning software and guidelines for quality assurance in photogrammetry, remote sensing and GIS. *Int. Arch. of Photogrammetry, Remote Sensing and Spatial Information Science*, 36(6): 65-70.
- König, G., Shortis, M. R. and Katterfeld, C., 2008. ISPRS activities on e-learning in photogrammetry and remote sensing and GIS - Status and challenges. In: Groenendijk, Liza, Lemmen, Christiaan: *Sharing Good Practices: E-learning in Surveying, Geo-information Sciences and Land Administration*, *Proceedings FIG International Workshop 11-13 June 2008, ITC, Enschede, The Netherlands*. pp. 283-301.

All links cited in the paper are accessed on June 12, 2009.

Case Study – Use of Video Clips in a Virtual Learning Environment to enhance the learning experience of our students.

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KEY WORDS: Video clips, student centred learning, multi layered teaching, enhanced student experience, student opinions

ABSTRACT

This paper considers how the use of video clips integrated into a virtual learning environment has been perceived by students on a land surveying module within a civil engineering degree. The increasing numbers of students joining many of our programmes has led to an increase in the number of students per practical group (now approx 90). This has resulted in a shortening of time available for one to one direct tuition in the use of surveying equipment. Thus some students may feel less confident in a group asking for procedures to be explained again, and the increasing pressures on student time means that some students miss important explanations. In order to facilitate a more one to one teaching environment it was decided to investigate the use of video segments to enable students to play and replay key processes in their own time.

Videos of parts of the practical sessions were created using a Sony Handycam, then edited to produce short instructional segments to enable students to view these in their own time, and critically in their own environment, and then to implement the key concepts from these clips within their practical sessions. A number of focus groups were convened to investigate the students' experiences of using this medium to enable them to increase their skills and competencies with surveying equipment.

1. INTRODUCTION

At the University of East London we have a long history of education within the land surveying field of study. As such we have a reputation for producing graduates who have an excellent grasp of changing technology as well as the theory behind measurement. With increases in student numbers and a decline in academic staffing levels over recent years, we decided that it was relevant to explore options to enable our students to benefit from, learn and engage with the technology used in land surveying in a supportive manner. These initiatives were designed to enable students to become familiar with different instrumentation while fostering a feeling of control of their own learning experiences. This coincides with the view of Laurillard (2002) in that the success of using any learning technology depends significantly on the ability to embed that technology within the existing learning context. In this case that could equally apply to both the use of specific surveying technology and also the use of video clips.

In this paper the authors will explore their motivation for inclusion of video clips in their teaching and also initial students' views on the usability and effectiveness of them as a learning experience. It will also give technical details of how the clips were created and made available to our students.

2. THE PROJECT.

Total Station instruments are an everyday tool of the practising surveyor and engineer and are the modern, digital equivalent of the traditional theodolite. Improvements to Total Stations to make them more efficient to use, to reduce the possibility of reading and transcription errors, and to add extensive automated functionality have been continual since their introduction in the early 1980s. However, the methods deployed to teach their use to prospective surveyors have invariably concentrated on the principles of surveying rather than using the equipment itself.

The advantages to the surveyor of the new instrument technologies have often focussed on the lowest common denominator of basic functions to speed up observations of angles and distances rather than the practical intricacies of the advanced features. Total station instruments produced by different manufacturers employ a range of different user interfaces. These differences are both digital and mechanical, meaning that menus, commands, terminology and controls all vary. These variations occur not only between different manufacturers but between the various models themselves. Over time this has made it challenging for educational establishments to keep fully up to date with changes in instrumentation. This may mean that, for some graduates, full familiarity with instrument capabilities has been left to post educational training from equipment suppliers and company in-house 'cascading' of knowledge to new employees.

The above problem represents a typical hi-tech dichotomy for educational establishments. Whilst it is inappropriate in the context of a degree programme to attempt to offer comprehensive technical training it is appropriate for students to develop relevant skills in modern and highly technical equipment. This project was therefore designed to enable our students to improve their familiarity with ranges of surveying equipment and in particular to address the issue of confusion that can arise in students' minds when presented with a wide range of varying interfaces found on instruments. The main aim of the project was to supplement and enhance practical classes through a series of video clips designed to illustrate the key points of complex practical tasks including instrument set-up, usage, testing and data logging. By freeing time from repetitive technical descriptions, lecture time could then be used to concentrate on core theory aspects. Critically, students would also be able to 'self-select' the correct video clip for the different instrumentation thus providing them with a personalised tool to engage with the practical aspects of their subject.

A comment sometimes heard from our students is that we as lecturers are there to 'make them learn', to 'teach' them, as if

somehow there can be a direct transfer from what we know to what they know with no application from their side. While this may, genuinely, be the view of some, for all students there is clearly the need to provide a beneficial learning environment which they can truly engage with and provide both the necessary technical and theoretical skills needed in the modern surveyor and civil engineer. *'If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving those outcomes....It is helpful to remember that what the student does is actually more important in determining what is learned than what the teacher does.'* (Thomas J Shuell 1986 cited Biggs 2003)

So how can we engage our students?

The last few years have seen a significant change in the student intake in many universities. This has principally been as a result of governmental policies of widening participation. One of the potential effects of increased numbers could be seen as reduced individual contact time and it may be feared that students could be left to cope without sufficient support. However, while it is clear that student numbers and profile has changed, it is less clear whether any real change has occurred in the teaching or support provision. But, as John Biggs (2003) said: *"Teaching and learning take place in a whole system, which embraces classroom, department and institutional levels,"* leading us to try to provide our students with a well rounded education, in order to ultimately provide graduates that will be in demand.

There is a clear need for students to engage with their own learning experience and it is also clear that there are many drawbacks with traditional methods of teaching such as 'chalk and talk'. In addition, traditional modes may not engage appropriately with students who lack familiarity or required social capital making them uncomfortable with the conventions of lectures, tutorials and self directed learning. We see a growing preference amongst students to use the facility we provide to download and print notes from our Virtual Learning Environment (VLE) as the core of their learning material. While digitally stored, but invariably ultimately printed out, this in itself can be seen as another out-dated, environmentally unfriendly and expensive mode of distributing information. It is also clear that students' familiarity and comfort with a range of alternative communication modes means that other opportunities now exist for us to explore these as methods of communicating our message. Students are more likely to relate to a text message, video clip, or social networking, so why not use this type of technology to engage the students by providing the necessary information for learning in the format they use and relate to the most. Malan (2007) argues that it is the ability of technologies to reach our students and engage them that we should claim as being the significant element in learning and teaching not the technology itself. Our very reason for being academics is to reach our students.

The ideas of podcasting lectures (or in our case video clips) are by no means new. In 2004 Duke University supplied iPods to their 1,650 first year students, (Chan & Lee 2005). These came preloaded with information on administration and a welcome to their students and the campus. After this initial induction use, they then allowed for lectures to be downloadable during the semesters. Further, we can see the rapid penetration of this technology by looking at iTunes University where we see a dramatic growth of courses offering information in a podcast format.

However, our aim has not been simply to utilise an alternative distribution medium but more than that we wanted to encourage our students to genuinely engage with the specialist technology of their discipline. As Hurst et al (2007) have stated, the ability to have lectures available any time any place any where (the Martini learning idea) would surely open up a new range of different learning scenarios. In line with this our aim has been to adopt a learning scenario where the students are comfortable with, and are not overwhelmed by, the use of technology. In planning the project, we needed to be very clear about what we would expect our students to do and what we would hope they would get from using the video clips. Appropriate duration of video segments was an initial problem to address. Chen and Lee (2005) questioned 26 first year students about their use of clips within an information technology module. One of the questions was the length of time they would be willing to listen to these clips per week. Over 50 percent said they would be willing to spend less than 8 minutes with 29.3% less than 5 minutes. So we wanted to create something that would be seen as beneficial, but was also relevant and concise. In fact, our final choice resulted in video clips of nearer one minute in duration as a compromise between hardware and software constraints and learning effectiveness. We were also concerned that the content had to have a practical element that was relevant and tied in with real practical tasks and problems so that students could instantly see that this could be beneficial. This echoes other evidence which links duration and structure to engagement, Malan (2007) notes that the use of 'bite-sized' videos offers students a more focused and structured knowledge on-demand service. In particular, we have noted that our students have been able to engage with not only their own learning experience, but have also had engendered a confidence in their own abilities to use the different instrumentation available to them.

3. METHODOLOGY AND TECHNICAL INFORMATION.

In order to produce the video clips, we chose a good quality camcorder with high-definition capabilities. Although the HD would be stripped off when compressed for final upload, we considered it better to have the full resolution when editing. The files could then be saved on a DVD so the video clips could be recreated at a later date, or re-edited.

Editing was critical, and careful choice of sequences was made to keep the clips to less than one minute duration. Initial tests showed that longer duration clips started to expose data capacity and replay issues as well as losing the students' concentration and interest. It was felt that if we could keep the clips short and to the point then students would be more likely to engage with them, use and reuse them and be able to self-select the relevant clip easily, rather than having to fast-forward within a clip to a short segment. To support the visual content, the text to accompany the tasks videoed was scripted and rehearsed, as is good practice with all video-making.

The Sony Handycam allows for recording in HD (AVCHD) format, which while providing a very good quality of playback does however result in 30MB per minute file sizes making them difficult to handle and requires higher than average specification PCs with extra RAM. The chosen file format of video storage was also an important consideration and we chose to adopt the most common file formats so that we could ensure the widest possible compatibility for the majority of students.

To support the formatting of the video clips and to help to ensure the desired compatibility with different playback devices, we used the VLC software package. VLC is available under the GNU General Public License (GPL) and is therefore downloadable for free. This program emulates the functions of a mobile media player, so that video clips can be checked before they are uploaded. This is a vital step as there can be significant differences between what we see on the computer screen and how it will appear when replayed on a small screen on a mobile media player or mobile phone.

When creating the final files for distribution, our investigations also indicated the relevance of selection of both the file format and the compression parameters set within the format. While this is a standard consideration, when creating files that can be used on a very wide range of devices, it becomes all the more important. Our target playback options initially concentrated on PC based viewing following by a download from the VLE and playback on MP4 players and we subsequently added mobile phone playback to this. Although compression settings can easily be adjusted to produce small files, heavy compression comes at the expense of quality, (Pinnacle Studio User Manual 2008). The authors would recommend always keeping a copy of the original recording in HD in order to facilitate further manipulation.

The Pinnacle video editing software used in this project has the ability to deal with a wide range of video file formats including AVCHD. Additional output formats include iPod compatible files as well as WMV (Windows Media Video). However, new formats arrive on the scene continuously and the MP4 players we selected implement their own file format, the AMV (Advanced Media Video). This format, which has been designed specifically for use with such players, compresses the video signal and audio stream to a convenient size file which plays back on a 50mm screen. However, such files are compressed so much, that play back on a full-size computer screen is not to be recommended due to the pixilation of the image.

A brief step by step procedure is detailed in the following table:

<i>Process</i>	<i>Hard / software</i>	<i>Format</i>	<i>File size (1 minute)</i>
Record the video	Sony cam-corder	AVCHD	30MB
editing	Pinnacle	AVI	220MB
Clips for VLE	Pinnacle	WMV / ZIP	3.7 Mb
Clips for MP4	WMV-AMV converter	AMV	2.0 Mb
Clips for phones	Pinnacle iPod	MP4	3.7 Mb

3.1 The Role of Technology in Students' Experience

The development of mobile devices is such that mobile phones are now far more than just a device for talking to colleagues and

friends, as they include internet and Bluetooth technology, opening up a whole new world of communication to a generation unhindered by tradition. Alongside this, devices such as the iPod have realised and revitalised the concept of mobile entertainment. While initially developed for listening to music while on the move, an idea introduced in the 1960's with the transistor radio, the iPod and its rivals now offer the chance to watch movies and television programmes, not only anywhere, but critically at the convenience of the consumer. The popularity of such media players can be seen from the estimates of how teenagers divide their non-school time among their pastimes, suggesting that as much time is now spent using these mobile devices as is spent watching television (Shiels 2008). Therefore, it can be seen that such technology has become second nature, and a media that our students are well versed in using. The possibilities of using podcasting and video podcasting or as in our case video clips in knowledge management are limitless (Ractham & Zhang, 2006). So we needed to make it as easy to use, portable and equitable for all our students on this module.

Although iPods are relatively cheap for an individual, a class set could potentially be prohibitively expensive. However there are now MP4 players on the market costing as little as £20 (GPB) each. For this project we chose one such device, the TeckNet V80 which offers a 1.8" TFT Screen, 2Gb of storage and playback of MP4/MP3 files. We selected this particular device, not just by virtue of unit cost, but also because these mobile units could provide the flexibility we sought for mobility for teaching practical sessions and could be economically viable as a bulk purchase. Thus we could enable students without their own personal player to still make use of this initiative. Our aim here was that video clips of more advanced procedures using survey equipment, such as setting out using Total Stations, can be stored on the player, kept in our survey store and signed out with the equipment. In this instance, students can playback the video clip while in the field and learn through emulating the procedure as it is demonstrated on the screen. This approach would allow students to work at their own speed, pausing and repeating elements as required. Making the video clips available alongside the equipment was, in our view, a key component of integrating the students' learning experience. This would support students who make use of survey equipment at times other than when the lecturer is available and as they pursue their own self-directed learning at their own pace. In addition students could also apply their skills using different equipment from different manufactures with confidence that they would be able to familiarise themselves with the change in the system.

In addition to the core video clips, we made use of the functionality built into the MP4 players allowing sub-titles to be displayed over the video stream. This capability was originally designed to display lyrics as music was played. From our perspective we could make use of this approach as an additional resource for those students for whom English is not their first language. This would make these video clips invaluable where the use of supplementary material or explanation is required. (Frydenberg 2008)

A further capability explored with the MP4 players was the option of displaying photographs and graphics in JPG format. This allowed upload of PowerPoint screens which, while saved as JPG so without any animation, would allow further presentation of structured material. Furthermore, WAV files (.WAV) could be created and used to talk students through core processes, again making use of sub-titles. By integrating different material formats and by use of the standard MP4

device functions we could thus combine a range of materials and cater for different students' learning styles and needs.

The files used on the mobile devices were also made available on the VLE. These could then be watched on-screen or downloaded to individual students personal players. There was also the request from students that they be made available in a format capable of being downloaded onto mobile phone from the VLE.

3.2 Using the MP4 player

Our initial tests of the equipment highlighted a number of environmental and usability concerns. To begin with we issued two MP4 players to the students. However, we soon found that the use of the players outdoors was less than ideal as there was too much glare to see the screen. Furthermore, sound replay was inadequate above the general outdoor background noise. It should be noted though that we are based in a relatively noisy environment as we are located on the side of The Royal Albert Dock in London opposite the London City Airport. The alternative we tried, and driven by the request of students taking part in the experiment, was to transfer the clips to their mobile phones using Bluetooth. Using this approach playback was far better although still quiet.

4. STUDENT VIEWS.

From our research, our initial findings have been very positive as to the benefits gained by students from these teaching aids, when implemented on a range of devices. Students were interviewed during a practical class when they were using video clips in support of their work setting out coordinated ground points using a Leica total station. Their comments ranged from, *'it was great as you could see and hear the stages needed'*, to *'would have been better on a bigger screen if it was not so sunny!'* Evidence from the students suggests that they found the length of video clip used, at approximately one minute duration to be appropriate for the tasks covered and the support required. Furthermore, and encouragingly, students also indicated and they would definitely use the video clips again. They welcomed the ability to be able to take the MP4 devices and the video clips out with the equipment as this enabled them to become familiar with the instrumentation in their own time. Students also noted the benefit of being able to use the material without the added pressure of not only having to complete a task in the practical class but potentially having other members of their peer group watching them struggle with the technology.

Discussions with the students also brought out more information regarding their experiences of using this type of technology to enable and enhance their learning. Four students mentioned that they had regularly used YouTube to view clips on mathematical operations to enhance a module they had sat the previous semester. They did however agree that the longest they would like to listen to such a clip would be 5 minutes, thus echoing the research of Chan & Lee (2005).

Further valuable comments made by the students included that they would like to be able to watch the video clips on a large screen, at home, prior to carrying out work in the field. This would enable them to see what to do, then use the MP4 as an aide memoir in the field. If the clips were available in this dual format and downloaded from the VLE and viewed in the comfort of their own home or in the class before the practical they thought this would give them more confidence especially when faced with slightly different instrumentation than they had

used before and were thus already familiar with. They saw this as a very practical way of enabling them with skills that would be needed in future employment, when they would be faced with the use of different instruments, some of which they may not be familiar with.

To enable this latter facility, and to pass on the advantage to the students, the files had to be reformatted so the students could access them at home. As the AMV had lost a lot of detail, it was necessary to add in an additional editing step and return to the data stored in Pinnacle and output it in a suitable format. The main issue with displaying through the VLE is the limit on the size of the file that can be uploaded. Although most VLE's can accommodate 10MB, such files are difficult for some students to download, and virtually impossible without broadband, so the high definition video was found to be unsuitable in this situation. In the end, we decided the WMV would suffice, given the quality of the playback, the size of the file and the ease with which students could playback the clips on their own or the University's computers usually without any extra software.

Basic videos explaining the setting up of the total station or levelling were considered, but as every group of students in the current cohort had already completed such a task, and due to the 'two-handed' nature of the process, it was felt that the portable device could possibly get in the way. As this project has proved to be a success, we will create more of them for use at the start of the semester, taking in to account the need to provide different formats, including purely audio podcasts.

5. CONCLUSIONS

This initial exploration into the potential use of this technology to enhance our students' learning experiences can be seen as successful albeit with a few operational difficulties to be resolved as we progress in the future.

While students took to the concept developed here well, the glare from the sun on the viewing devices and the sound quality were perceived as drawbacks. However these are relatively minor issues that can be resolved principally with the introduction of higher quality clips viewable via the VLE and viewed before outside activities take place. Also, the inclusion of subtitles could enable students to view the clips but not have to listen to the commentary. However, the production of simple audio files would also allow them to listen and follow the steps without the need to follow on screen instructional material. On the positive side, students did like what they saw and did actively say they would use this again and would like to see it in a variety of different modules.

The introduction of the video clips and the use of VLE's has expanded the range of ways that knowledge can be disseminated to the student body and makes effective interaction through a variety of media. This has enabled us to implement a multi-layered learning approach where the 'chalk and talk' of yesteryear can be replaced by a combination of interactive tools, traditional lectures, seminars, reading material, video clips etc. All students, regardless of their own individual learning style, are then able to access information in a way that is relevant and meaningful to them.

It is hoped to continue this project with other cohorts of students, which would result in the potential to create a fully comprehensive library of video clips that can be used throughout the programme. By embracing the technology that our students are familiar with, in a way that enables our

students, but does not intrude, it is envisaged that this will enhance their experience. Thus we aim to customise our work so as to aid and not invade our students' learning space.

REFERENCES

- Biggs, J., 2003. *Teaching for Quality Learning at University* 2nd edition, The Society for Research into Higher Education and Open University Press.
- Chen A., & Lee MJW., 2005. AN MP3 A DAY KEEPS THE WORRIES AWAY: Exploring the use of podcasting to address preconceptions and alleviate pre-class anxiety amongst undergraduate information technology students. *Student experience conference – Charles Sturt University 2005*.
- Hurst W., Melte M., & Jung S., 2007. An evaluation of the Mobile Usage of E-Lecture Podcasts. MC'07 (Mobility'07) September 10-12 Singapore
- Laurillard, D., 2002. *Rethinking university teaching: a conversational framework for the effective use of learning technologies* (2nd ed.): RoutledgeFalmer.
- Malan DJ., 2007. Podcating Computer Science E-1 *SIGCSE'07*, March 7-10, Covington, Kentucky, USA.
- Pinnacle Studio User Manual. 2008 v.12 p209.
- Rchtham P., & Zhang X., 2006 Podcating in Academia: A new Knowledge Management Paradigm within Academic Settings. *SIGMIS_CPR'06 April 13-15* Claremont, California, USA
- Shiels M., 2008. Online time 'is good for teens' BBC, England <http://news.bbc.co.uk/1/hi/technology/7740895.stm> (assessed 1st May 2009)

RECENT ACADEMIC ACHIEVEMENTS OF E-FOTO GNU/GPL EDUCATIONAL DIGITAL PHOTOGRAMMETRIC WORKSTATION

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Commission VI, WG VI/1, VI/2

KEY WORDS: Digital photogrammetry, Education, Digital Photogrammetric Workstation, Free Software, Educational Commons

ABSTRACT:

The privacy of source code makes, in many situations, commercial application software unable to academic purposes. Such applicative programs are like “black-boxes”, allowing only data input and results output, as a function of the graphical user interface manipulation. It strongly hinders their application to education, since users remains alienated of what exactly is performed in the applicative background. A common proposal for overcoming such limitations is the development and usage of free software. The academic community of distinct knowledge areas is, indeed, being benefited by free software development for educational and research purposes. However, Digital Photogrammetry is a field that remains practically unexplored. One exception is the E-FOTO project, which develops the only GNU/GPL environment for research, teaching and learning of Digital Photogrammetry that encompasses an Educational Digital Photogrammetric Workstation (EDPW). E-FOTO project aims at producing and sharing without limitations with the academic community software and documents. This paper is devoted to the pedagogical design of E-FOTO Educational Digital Photogrammetric Workstation, besides the project main achievements and repercussions. Along this paper, it is shown what tasks of the photogrammetric process should be covered by the EDPW, the free electronic version of the only digital photogrammetry book edited in Brazil, the software tutorials and the self-learning conception of E-FOTO. Finally, the future expectations for this project are enumerated.

1. INTRODUCTION

Recent corporative scenarios have been imposing changes to the professional profile, demanding people able both to learn in non-conventional ways and to work collaboratively to engender innovative solutions. As a consequence, the technical-based education must rethink about the established focus in order to improve skills and competencies in students, such as learning to learn and to learn with autonomy in a scientific and technological environment (Longo, 1996).

In engineering education, these challenges can be addressed with an integrated approach putting together teaching, learning and research, where the computer plays a significant role. It allows students, for example, to develop and test alternative assumptions, implementing their designs and models, to build a variety of representations for the studied phenomena, by using different kinds of language and levels of abstraction. Besides, in a digital environment, it is possible to simulate events in different scales and values, slower or faster than in nature, overcoming costs, complexity and danger.

Another interesting possibility due to computers and the Internet is collaboration; by such means students can work together and share their assumptions, ways of solving problems and results.

In the specific case of the cartographic engineering education, Digital Photogrammetry's teaching and learning process (Coelho Filho and Brito, 2007) is a critical component, where computers play a key role. That has motivated E-FOTO project, whose major objectives address researching, developing and

implementing a framework for teaching, self-learning and research of Digital Photogrammetry.

The current paper is devoted to the presentation and discussion of the technical and pedagogical aspects of the E-FOTO project. To achieve that purpose, section 2, briefly, presents the basis of Digital Photogrammetry teaching and learning process. Section 3 offers a comprehensive overview of the project, focusing on its educational aspects. Section 4 exposes our conclusions and the future works related to E-FOTO educational tools development.

2. DIGITAL PHOTOGRAMMETRY EDUCATION FUNDAMENTALS IN ACADEMIC ENVIRONMENT

Photogrammetry is a set of technical procedures for processing photographic imagery (2D image-space) aiming the mathematical modeling and reconstruction of a 3D scenario (the terrain or the object-space). The state of the art of photogrammetry is what is so-called “Digital Photogrammetry”, which uses either digital or digitalized-frame imagery and computational processes besides algorithms for scene reconstruction.

The utility of digital photogrammetry goes from the virtual reality to Medical applications. One could mention, for instance, the volumetric quantification of lung cancer nodules, from a set of images taken by a helicoidal tomograph (Mota and Brito, 2005). The non-invasive surveying of archaeological sites and the record of historical monuments and buildings are also possibilities of application of photogrammetric techniques (Kraus, 2000). Topographic mapping generally employs digital

photogrammetry for imaging earth surface and for its 3D mapping.

The set of hardware and software components able to perform the photogrammetric tasks is what is meant by a “Digital Photogrammetric Workstation (DPW)” (Brito and Coelho Filho, 2005). Indeed, DPW’s are solutions of photogrammetric software that came out in the early 1990’s to substitute the opto-mechanical stereo plotters (Phem and Grabmaier, 2004). Besides, the development of electronics and computer science has been opened new opportunities in the areas of hardware, methodology and integration.

Many factors have contributed to the fast development of digital photogrammetry. (Dowman *et al.* 1991) pointed out: (1) the increasing availability of digital imagery, especially from (high-resolution) satellite born sensors; (2) the availability of computers and workstations with high-capacity CPU and with many innovative and reliable photogrammetric accessories; (3) the data integration in one single computational system such as the Geographic Information Systems (GIS); (4) the real-time applications, and; (5) the CAD software and the industrial applications.

One obstacle to the insertion of the state of the art photogrammetric hardware and software in educational environments is the unaffordable prices of photogrammetric software licenses. This reality imposes many restrictions to the integration of theory and practice in educational programs, thus, leading to weakness in the curricula of cartographic and surveying engineering courses.

Due to the intensive use of digital computers in the context of cartographic mapping production, two skills need to be developed: on one hand, the algorithms and the mathematics embedded on the photogrammetric procedures needed to be clearly understood. The same reasoning applies to the quality control of results and products derived from the photogrammetric mapping. On the other hand, it is necessary to understand the concepts behind the workflow of the photogrammetric mapping process implemented in a DPW.

Professionals with no practical experience are certainly one of the consequences of the development only of the first skill above mentioned. In addition, the lack of knowledge about the algorithms applied in each step of the photogrammetric workflow forms professionals without critical sense and with difficulties of adaptation to the technological development. The black-box architecture of commercial DPW solutions is responsible for this limitation (Brito *et al.*, 2006).

According to (Coelho Filho and Brito, 2007), the core of topics related to digital photogrammetry comprises the following: (1) introduction to photogrammetry; (2) basic principles of photogrammetry; (3) digital image processing applied to photogrammetry; (4) inner orientation of digital imagery; (5) exterior orientation of digital imagery; (6) analytical phototriangulation; (7) image rectification and normalization; (8) digital surface model extraction; (9) orthorectification, and; (10) photogrammetric mapping stereo-plotting. Table 1 shows a comparison between the syllabi of a reviewing course and three Master Courses in digital photogrammetry with the Modules of the Educational Digital Photogrammetric Workstation (EDPW) developed by the E-FOTO project.

	<i>Digital Photogrammetry Courses</i>				<i>EDPW</i>
<i>Topics</i>	(1)	(2)	(3)	(4)	
Introduction	X	X	X	X	
Image Acquisition	X		X	X	
Image Rectification			X		X
Inner Orientation	X	X	X	X	X
Exterior Orientation	X	X	X	X	X
Phototriangulation	X	X			X
Digital Image Processing and Template Matching	X			X	
Image Normalization (Epipolar Resampling)	X		X	X	X
Digital Surface Model Extraction	X	X	X	X	X
Ortho-rectification	X	X	X	X	X
Photogrammetric Mapping Stereo-plotting		X		X	X
Close-Range Photogrammetry	X				
(1) Master Degree in Geographic Engineering - The Coimbra University, Portugal (2) Reviewing in Digital Photogrammetry. ITC, The Netherlands (3) Master Degree in Geomatics – Uerj, Brazil (4) Post-Graduation Program in Cartographic Sciences – Unesp, Brazil					

Table 1. Comparison of the syllabi of four courses in digital photogrammetry with the modules of the EDPW Implemented in the E-FOTO Project

One could observe in Table 1 that most of the parts of the core subjects in digital photogrammetry syllabi are covered by the EDPW implementation. Therefore, E-FOTO's educational environment permits students to analyze the didactic contents of the photogrammetric topics, to manipulate and to establish relationships between variables and the performance of the algorithms, and to become familiar to the mathematical principles behind the implemented solutions (the white-box approach). The study of the orthorectification, for instance, aims at transforming central-perspective images onto orthoimages. According to E-FOTO's pedagogical philosophy, there is no sense in introducing both the central perspective and the orthogonal one without explaining the mathematical principles and algorithms underlying the orthorectification process.

3. THE E-FOTO PROJECT

Digital photogrammetry has been employed in large scale since 1995. In under development countries, its popularisation came later. For instance, in Brazil, according to (Brito and Coelho Filho, 2005) its utilization started in 1998. The state of the art of digital photogrammetry involves the usage of DPW. Although a DPW encompasses a dedicated hardware and software, this term will hereafter refer to software.

As previously mentioned, the commercial value of a proprietary DPW licence – in the order of thousands of dollars – hinders its use for educational purposes. Nonetheless, even institutions in economic conditions to effort the licence cost can conclude that their exploitation for educational purposes is limited. First, it is due to the fact that the employed algorithms are kept as business secret. Moreover, in most cases, it is not possible to include user-developed solutions and algorithms. Indeed, like any proprietary system, commercial DPWs are black-boxes. Thus, their usage for didactic and research purposes is, in fact, very limited.

The E-FOTO project tries to overcome these difficulties by the development of an EDPW based on the free software community principles. Since it is an open source project, the “black-box” can be opened, examined and modified for those with the will and the skill to investigate (Nichols and Twidale, 2003). Such aspects bring considerable advantages: any one can freely use it, study its source code, develop additional algorithms and redistribute it.

The EDPW comes alongside with several E-FOTO's products: (1) an e-book of digital photogrammetry; (2) the only digital photogrammetry book edited in Brazil; (3) the EDPW usage tutorials; and (4) an Internet site that allows the distribution of the binaries, the sources, and didactic material as well. Considering the variety of its products, it can be asserted that the project is devoted to researching, developing and implementing an educational commons dedicated to digital photogrammetry.

The project began in 2002 as an undergraduate final project in the Cartographic Engineering Course at The Military Institute of Engineering of Brazil – IME (Coelho Filho, 2002). Presently, it is being developed under the Computer Engineering Masters Program, with emphasis in Geomatics, at The Rio de Janeiro State University (Uerj). E-FOTO's team joins researchers and students from undergraduate and graduate levels with different backgrounds.

This project has three basic principles: (1) entirely free access to component programs and sources, under the GNU/GPL license; (2) free usage of the related documentation and; (3) the availability of sample material. Another E-FOTO's aspect that must be emphasized is its self-learning philosophy which considers 3 levels of interaction between users and the project: level 1 is dedicated to beginners, level 2 to regularly subscribed students, while level 3 to the ones able to develop and to research new functionalities and algorithms.

The direct involvement of undergraduate students of computer engineering brings to the project another interesting feature: the human resources formation in free software development under collaborative environments. At anytime during the software development process, the improvement of the skills of its developers is a major concern. The following sections are dedicated to the presentation of E-FOTO's products.

3.1 The educational modules of the EDPW

Figure 1 presents an overview of a DPW's workflow. Through the decomposition in horizontal direction of this figure, the workflow can be divided into 3 groups: (1) input data; (2) photogrammetric processing; and (3) geospatial output data. The EDPW comprises 7 modules, each one designed to teach one step of photogrammetric process needed to operate the previously mentioned groups (2) and (3).

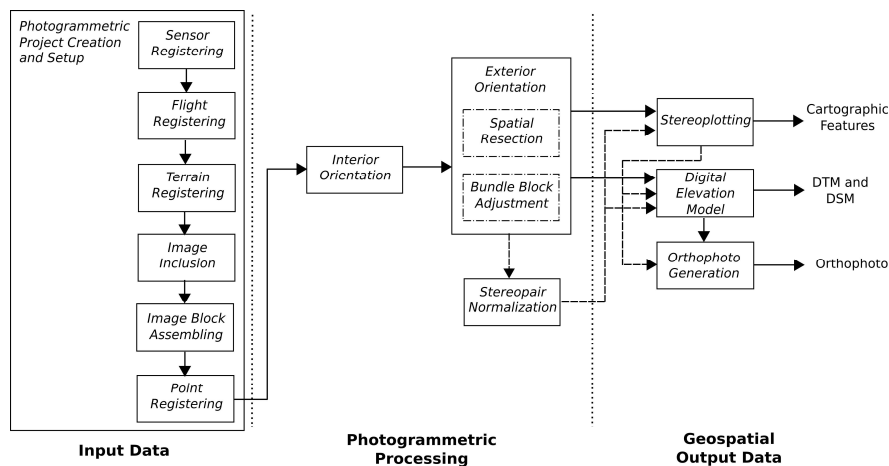


Figure 1. Overview of a DPW workflow

Figure 2 shows the project modules: (a) image rectification; (b) inner orientation; (c) exterior orientation; (d) phototriangulation; (e) stereogram normalization; (f) digital stereoplotter; (g) digital elevation model extraction and orthorectification.

Aided by this EDPW, users can intuitively accomplish the process and observe both the results and the respective quality parameters. Thus, it makes users able to the practical application of the theory shown in classroom and present in the literature.

3.2 Digital Photogrammetry Book

This book is an improved version of a former e-book about this subject that was produced in the early beginning of the project. The book Digital Photogrammetry written by (Coelho Filho and Brito, 2007) brings the basic theoretic foundations about this theme with no need of previous background. Most of its chapters are dedicated to the mathematical models of the photogrammetric process and to their geometric interpretation. Besides the previous mentioned authors, some of the book chapters count with the coauthoring of other project members. It should be stressed that it is the only photogrammetry book edited in Brazil with a full digital approach. In addition, although the book can be purchased in cost price at the Rio de Janeiro State University Publisher, it can be also downloaded free of charge.

3.3 Usage Tutorials

Several software usage tutorials are also available in order to complement the theoretical documentation. Such tutorials guide the step-by-step utilization of the modules. If employed alongside to the book, they permit the comprehension and

approximation between theoretic and practical aspects of this theme.

3.4 E-FOTO's Web Page

E-FOTO's web page, <http://www.efoto.eng.uerj.br>, gathers and gives access to all project products, including scientific publications. That is a mean to achieve the project principles of liberty and self-learning. It also paves the way for improving both communication and cooperation among developers and users community. Such collaborative philosophy is underlain on the Internet, whose existence has facilitated the coordination of volunteer developers around the world, to produce open source solutions (Nichols and Twidale, 2003).

Besides the following mentioned products, the project brought about: four master thesis; seven undergraduate projects; and a number of papers published in scientific congresses.

3.5 Considerations about the E-FOTO educational focus

One important issue for E-FOTO project is self-learning. To give support to that, students have free access to the previous mentioned products, can interact one to each other and develop software solutions for digital photogrammetric problems. The main goal of this self-learning focus is to stimulate students in the exploitation of available E-FOTO resources and to build mental connexions throughout practical activities.

In addition, the on going development of an e-learning tool brings about the discussion of the pedagogical aspects of the E-FOTO project. We notice that, in a broader sense, the teaching of engineering is not based in a pedagogical project aiming at the holistic and critical formation of the students, but mainly focused on technical knowledge. Indeed, at universities, it is not

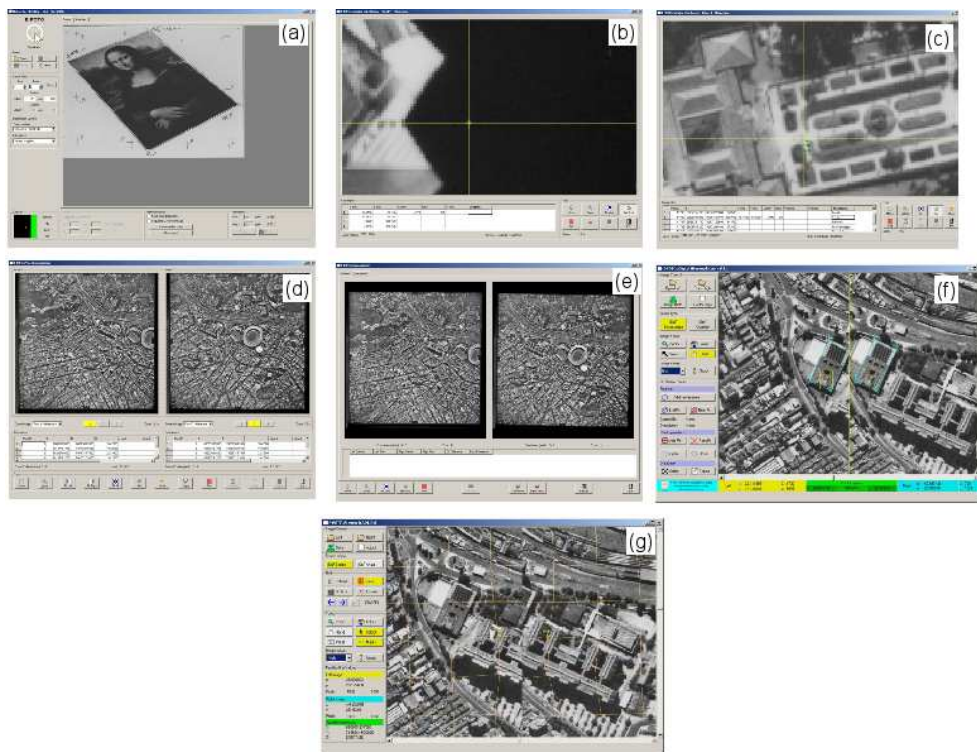


Figure 2. EDPW Modules (a) rectification; (b) interior orientation; (c) exterior orientation; (d) phototriangulation; (e) stereogram normalization; (f) digital stereoplotter; (g) digital elevation model and orthorectification.

unusual the application of an antiquated pedagogical approach based on a poor technical view of learning: students are considered as “tabula rasa” and regarding their evaluation professors rely primarily on memory training.

On the other hand, E-FOTO's principles require a distinct pedagogy, where students are active actors of the learning process. A theoretical basis of this point of view is the constructionist theory (Papert, 1990). This theory considers that our knowledge is not “about the world”, but “part of the world.” Knowledge is not viewed as a fixed object, but as a common good that is constructed collectively. In such process, each individual is supposed to bring his/her own experience about the subject. Besides, this approach emphasizes the need of stimulating projects in which students, professors and specialists have different responsibilities to reach out a common aim. The objective is to create learning communities concerned with collaborative practices in the real world. In such kind of environment, students assume part of the responsibilities for their own learning and the development of their metacognitive competences.

Collaboration is the key-point to constructionist theories. When people work in a collaborative way, they bring their own structures and perspectives to this activity. They can analyse a problem from different points of view and negotiate and produce meanings and solutions based on this shared comprehension.

The main goal of E-FOTO e-learning tool, currently in its early stage of development, is to deep the adoption of the constructionist learning approach. This requires a broader offer of spaces for the participation and cooperation, to stimulate the formation of communities directed to practice in real world problems – respecting previous academic and personal experiences of students – and the representation of the proposed problems in different formats by means of graphical, mathematical or computational solutions.

4. CONCLUSIONS AND FUTURE TRENDS

The E-FOTO project offers several contributions to society. The most important is the development of an environment for teaching and research, which has great importance for digital photogrammetry. The project allows students and researchers becoming familiar with the use and development of photogrammetric algorithms. In addition, E-FOTO overcomes the limitations imposed by proprietary software producers that keep hidden the photogrammetric knowledge.

E-FOTO's philosophy is inspired by free software philosophy, but brakes out its bounds. Together, its products bring about an educational commons aiming at the socialization of digital photogrammetry knowledge. According to (Silveira, 2007), the idea of commons brought a revolution in the symbolic production of mankind which has the ability to expand freedom, creativity and democracy. E-FOTO is an example of this.

The research framework developed by the project is consolidated and available. As a consequence, promising trends arise. First, it is the evaluation of end users' interactions with the platform, in order to collect qualitative and quantitative educational results. Another aspect is the development of a tool for e-learning. A key aspect in the E-FOTO educational design was the idea of self-learning, but this idea has evolved to the development of tools for assisted learning. The general idea of

an e-learning environment for the E-FOTO project is to integrate the already developed educational contents and tools to promote educational activities. This trend has just started. The aim is to produce a dynamic, interactive and self-explanatory remote educational web site using free software. It is intended to be an opportunity to offer the society access to an on-line environment, including virtual classrooms, evaluation, self-evaluation, communication channels for cooperative work and virtual communities.

REFERENCES

- Brito, J. L. N. S., Coelho Filho L. C. T., 2005. The E-FOTO Project - A Digital Photogrammetric Softcopy Kit for Educational Purposes.,” In: *Proc. 6th Geomatic Week Proceedings*, Barcelona, Spain.
- Brito, J. L. N. e S., Coelho Filho, L. C. T., Silveira, F. J. C.; Mota, G. L. A., Bernardo Filho, O., Ribeiro, J. A., Silveira, M. T., Fonseca, R. J. M., 2006. Projeto E-FOTO: O Desenvolvimento de um Ambiente Integrado para o Ensino de Fotogrametria Digital em Software Livre. In: *Anais da Workshop de Software Livre*, Porto Alegre, Brazil.
- Coelho Filho, L. C. T., Brito, J. L. N. e S., 2007. *Fotogrametria Digital*. EdUERJ, Rio de Janeiro, 196 p.
- Dowman, I.J., Ebner, H., Heipke, C., 1991. Overview of European Developments in Digital Photogrammetric Workstations. *Photogrammetric Engineering & Remote Sensing*, 58(1), pp. 51-56.
- Kraus, K., 2000. *Photogrammetry v. 1: Fundamentals and Standard Processes*. Dümmlerbuch, Vienna, 398p.
- Longo, W. P., 1996. “Reengenharia” do Ensino de Engenharia: uma necessidade. *Revista Segurança & Desenvolvimento*, 220, pp. 13-16.
- Mota, G. L. A., Brito, J. L. N. e S., 2005. Projeto Tomógrafo: Cálculo do Volume de Nódulos Pulmonares a Partir de Imagens de um Tomógrafo Helicoidal. Projeto de Fixação de Pesquisador FAPERJ, Rio de Janeiro, RJ, Brazil.
- Nichols, D. and Twidale, B., 2003. The Usability of Open Source Software. *First Monday*, 8(1).
- Papert, S., 1990. *Introduction: Constructionist Learning*. Idit Harel (ed.), MIT Media Laboratory, Cambridge, MA.
- Phem, S., Grabmaier, K., 2004. Refresher Course on Digital Photogrammetry. In: *Proceedings ISPRS Congress, Proceedings of Commission VI*, Istanbul, Turkey.
- Silveira, S. A., 2007. Redes virais e espectro aberto: descentralização e desconcentração do poder comunicacional. In: Silveira et al. *Comunicação digital e a construção dos commons: redes virais, espectro aberto e as novas possibilidades de regulação*. Editora Fundação Perseu Abramo, São Paulo. 176 p.

VISUALISATION OF HYDROLOGICAL PROCESSES WITH GEOVLEX: INTRODUCTION OF AN INTEGRATED METHODOLOGICAL-TECHNICAL ONLINE LEARNING APPROACH

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KEY WORDS: e-learning, geovisualisation, geosciences, hydrology, GEOVLEX, models

ABSTRACT:

Geosciences deal with complex, interdependent landscape processes, of which hydrological processes are an important example. Understanding such processes in time and space is crucial in geoscientific research and education. Addressing and communicating hydrological processes using traditional teaching methods (e.g. blackboards in lectures, printed study books) is rather limited though. Hence, within the framework of the geoscientific e-learning platform, novel online learning modules are being developed to allow a better understanding of the aforementioned processes.

The integration of new photo-realistic geovisualisation and web-based approaches are effective means to impart knowledge if designed accordingly, as the perception of a geovisualisation and its contents vary strongly depending on various factors. Therefore, to make use of all advantages of geovisualisation, their methods and characteristics have to be chosen carefully.

The departments of geosciences and computer science develop methods to visualise landscape processes based on precipitation-discharge-models that are directly integrated into e-learning environments. With the help of those online learning modules, users have the possibility to visualise the effects of dynamic variances in the landscape balance on discharge behaviour in small and medium catchment areas interactively and on-the-fly.

1. INTRODUCTION OF THE GEOSCIENTIFIC E-LEARNING PLATFORM GEOVLEX

The name of the online portal GEOVLEX (www.geovlex.de) – geovisualisation, virtual landscapes, and virtual excursions – represents the content of the elearning initiative of the department of remote sensing and cartography, which now exists since 8 years. The development of the learning portal is based upon two research projects. The learning portal WEBGEO (webbing of geo processes, www.webgeo.de) for the basic education “physical geography” was developed until 2004 in cooperation with eight German universities, being funded by the BMBF program “Neue Medien in der Hochschulausbildung” (“New media in university education”). This multiple price winning joint project served as the bases for subsequent, decentralized enhancements of the WEBGEO network by means of loan programs through the German states. This way, it was possible to lastingly stabilize the e-learning know how generated by WEBGEO. The financing of the project GEOVLEX was carried out in Saxony-Anhalt within the loan initiative “Multimedia in Lehre und Studium an den Hochschulen des Landes Sachsen-Anhalt” (“Multimedia in training and academic studies at the universities of Saxony-Anhalt”). The initiative ended in December 2006. Henceforth, GEOVLEX is continuously enhanced by the initiative of the authors and, if possible, with help of scientific assistants.



Figure 1: Portal of the geoscientific e-learning platform GEOVLEX (www.geovlex.de)

2. THE E-LEARNING CONCEPT OF GEOVLEX

The concept of blended learning (see Sauter et al. 2004) was consistently realized from the very beginning. Criteria for this decision resulted from different aspects:

- The Online portal aims to enrich traditional teaching and learning methods and should not replace them. Exchange and acquisition of knowledge are carried out in an open didactical and methodological field of activity and allow for different and individual learning types
- Multimedia-based applications allows for a huge diversity of new learning concepts
- Communication between teacher and learner is not to be replaced but completed
- Within the applications the scope is on interactivity and multiply usable 3D and 4D visualisation of geo-processes
- Numerous integrated interactive tests allow for immediate and autonomous control of the achievements

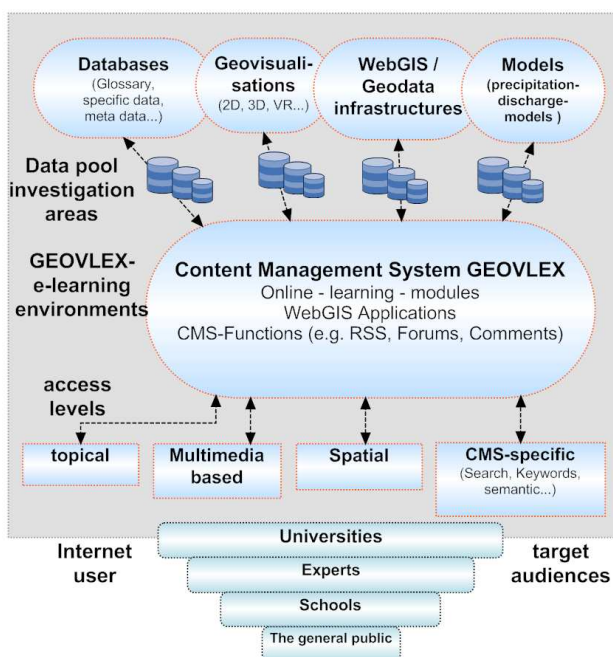


Figure 2: The scientific – technical approach of GEOVLEX

The chosen blended learning approach served as base for the conception of the learning platform. Figure 2 schematically shows the scientific–technical realisation of GEOVLEX. The use of learning management systems, that already existed, turned out to be inefficient due to the specifically geo-scientific requirements (spatial-relation of the learning application and visualisations). That is why the portal is based upon an ad hoc programmed and database supported learning environment, which is embedded into a content management system (CMS). The CMS is used for advancement in teacher – learner communication.

The GEOVLEX applications, i.e. online-learning-modules, virtual excursions (Gläßer & Thürkow, 2004; Thürkow et al. 2005), glossary- and subject databases, geovisualisation and WebGIS-applications combined with geodata-infrastructures, are typically cross-linked within the CMS. Numerous subject and geo-related data is integrated with the help of ontology-based frameworks. This procedure is described in detail in Scheuer et al., 2009.

Every module can be used freely and mutably by teachers and learners alike in connection with courses or for private study.

The different access possibilities to learning content by means of the service-based applications also account significantly for the academic achievements. The composition of GEOVLEX is thereby subject to severe regulations and standards.

Multiple choice, drag & drop and cloze texts are primarily used within the tests and exercises. For more demanding exercise environments, independent use of formula and drawing of data into learning objects is requested. The integration of data-based tests and exams is planned. However, at this point further research and development is needed, which asks for an advanced cooperation with didactics and computer science.

3. GEO-VISUALISATION SUPPORTS ACADEMIC ACHIEVEMENTS – EXAMPLES FROM HYDRO SCIENCE

Interactivity is one of the main properties of the multimedia-based applications of GEOVLEX. The triplet investigation area – topic – time is decisive for the visualisation of hydrological processes. The multidimensionality, which today mostly occurs in a 3D version, is labelled as 4D in combination with the time constituent, which is of high relevance for the geo-science. The time-level vary thereby within extremely different scales.

First example:

The GEOVLEX Online learning-module (GOLM) “Dynamik von Bergbaufolgelandschaften” (“dynamic of post mining landscapes”) dealt with the genesis of the post mining Bitterfeld- Goitzsche region. The period of examination of geo-processes covers several decades (see figure 3, URL 1). The anthropogenic interference with the nature by means of brown coal mining is illustrated with the support of interactive maps and animations. Effects on the hydrological cycle through different processes can be deduced through learning by doing. Today, the Goitzsche serves as an important recreation area in the region of Central Germany. The water body of the lake “Großer Goitzschensee” covers more than 12 km² and has a capacity of approximately 208 million m³. The former environmental disasters of the region by means of interference with the landscape through the opencast mining is due to the recreation no longer traceable. Therefore, the learning module not only contributes to a better understanding of hydrological processes but also accounts for environmental education in situ.



Figure 3: In learning module integrated geo-visualisations, which explain the change of environment in a certain region

Second example:

In contrast to the first example, GOLF “Entstehung und Ausprägung von Hochwassern” (“Origin and development of flooding”) deals with hydrological processes which elapse in a short period of time (see figure 4, URL 2). Processes within flood events are highly complex. The comprehension is often demanding for students. Realistic virtual landscape models and geovisualisations were developed in order to efficiently encourage the academic achievements. Those allow for an interactive and illustrative exploration of flood values. Moreover, within this learning module, certain factors of the origin of flooding, flood types, and flood damages are conveyed. The comprehension of the impact of global warming on the frequency of flooding is encouraged with the help of an interactive drag & drop exercise.

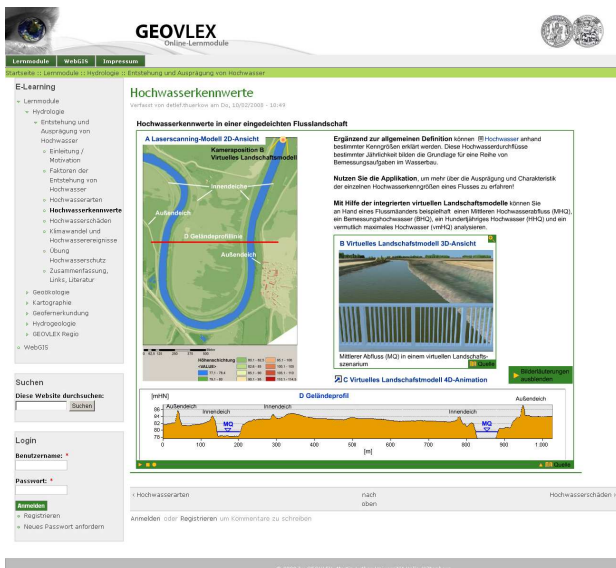


Figure 4: Screenshot virtual scenery of occurrence of flood values in an embanked fluvial topography

The academic achievements shall be increased by means of the integration of specific data and metadata from research projects, which are available for analysis and presentation through WebGIS and database supported web applications. Figure 5 exemplarily illustrates applications from a flood information system of the opencast mining Goitzsche. Spatial – time components are ontologically crossed-linked and serve to document the opencast mine flooding within the scope of reconstruction. Hence, in addition to the common presentation of knowledge, users are able to analyse and visualize values of different processes.

To get more information about the integrated approach to geographic data processing and geo-visualisation in the open, modular system from GEOVLEX, see Gläßer et al. 2009.

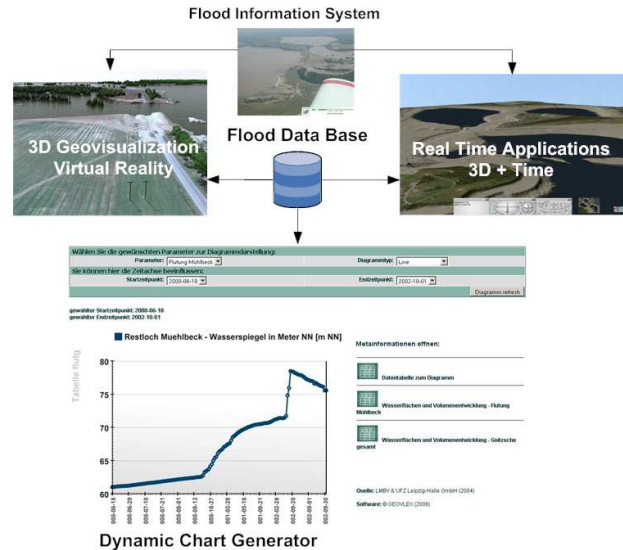


Figure 5: cross-linking of GEOVLEX components to illustrate processes

4. INTEGRATION OF PRECIPITATION-DISCHARGE-MODELS INTO E-LEARNING ENVIRONMENTS

The enhancement of the methodological-technical approach is in progress at the moment. A learning-module on hydrology linked with a model is under construction in cooperation with the Institute of Computer Sciences. In this module, users have the opportunity to model scenarios of precipitation runoff models for smaller and medium watersheds. The calculation of components of the water balance equation can be modularly implemented:

- precipitation (Thiessen Polygons)
- calculation of potential and effective evapotranspiration (Haude), (DVWK, 1996; Dommermuth & Trampf, 1991; Großmann 1996)
- calculation of immediate runoff of precipitation events on the basis of the SCS-method by the US SOIL CONSERVATION SERVICE (see Maniak, 1997)
- calculation of surface runoff of with the help of the rational method (USDA 1986)
- calculation of soil water balance including infiltration

Based on the linking of models, the user shall be able to interactively explore the different values of particular area parameters, such as climate, soil, vegetation and land use, and their effect on the runoff formation. Input data for three differently structured landscapes (central German arid environment, the Ore Mountains, the alps) is provided for the learning module.

Moreover, the user shall be able to use data from their own investigation areas. Therefore, predefined data types and data structures have to be used.

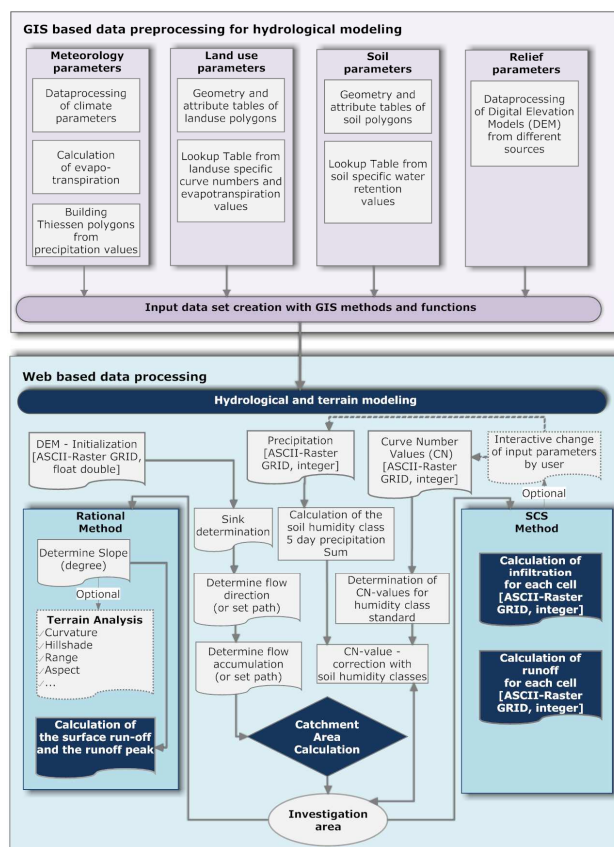


Figure 6: Process flowchart of the underlying data processing and hydrological modelling of the GOLF to the water balance of different catchment areas

All calculations shall be analysed and visualised in a WebGIS-framework (Scheuer et al., 2009) after completion. Furthermore, users should have the possibility to save the calculated geo-datasets on their local systems.

On the part of the Institute of Computer Sciences, efficient algorithms, which are needed for a web-based realisation of a learning module, are implemented within the framework of a degree dissertation. Parallelisation is traced within this context. The aspects that are traced within this context include for example:

- aspects of data exchange
- integrity of real parallel data structures
- prevention of redundancies, as well as deadlocks
- utilisation of cache-effects

The aim is to considerably accelerate calculations within the learning module. Accordingly, the parameters that are related to catchment areas shall be calculable within an arguable time range. For this purpose, many-core architectures are the core of researches of strategies for parallelisation. Main properties are therefore the reduction of computing and response time. The realisation shall be carried out with the help of parallel threads, whereas calculations and accesses on the required data are to be superimposed as far as possible.

Figure 6 illustrates a flow scheme on the intended methodological realisation of the linking of models from a geo-scientific point of view.

5. CONCLUSION

The e-learning methods developed in GEOVLEX do not only apply to hydrological topics. Modules on cartography, remote sensing, geo-ecology, geomorphology, geology and so forth are also realised. Thus, parts of the already described methods have already been successfully transferred to other fields of applications, as well as other user groups. The tools were nationally and internationally meet with vivid response. Users of the developed modules in the German-speaking region are students and lecturers of universities, alongside with numerous grammar school teachers. At the moment, there are more than 60.000 accesses on the web based services of GEOVLEX monthly, with an upward trend.

The quality of knowledge conveyance within the geo-sciences is selectively increased by the integration of geovisualisations and interconnection of models in online learning modules of various problems. The huge costs which result from the implementation phase are only reasonable if there is an increase in academic achievements for the users accordingly. The choice of the methods therefore needs to be exactly measured in regard to costs and benefits.

The modules of GEOVLEX are partly applicable for adoption outside university training. Already in demand are tools for environmental education and public sectors. Trendsetting prospects, which derive from geo-multimedia, not only for geosciences but also for other fields which are engaged with geo-data, such as agriculture, phytogeography, history or archaeology, are not yet in every extant identified. At this point, numerous varying possibilities result, which lead to future multidisciplinary cooperation within the e-learning sector. The question of finance remains open at this point.

REFERENCES

- Dommermuth, H., Trampf, W., 1991. Die Verdunstung in der Bundesrepublik 1951–1980. Deutscher Wetterdienst, Eigenverlag, Offenbach.
- DVWK, 1996. Ermittlung der Verdunstung von Land- und Wasserflächen. DVWK-Merkblätter 238, Bonn.
- Gläßer, C., Thürkow, D., 2004. Virtuelle Landschaften und Exkursionen – innovative Tools in der geowissenschaftlichen Aus- und Weiterbildung. Photogrammetrie-Fernerkundung-Geoinformation, 5, pp. 391-398.
- Gläßer, C., Thürkow, D., Dette, Ch., Scheuer, S., 2009. Development of an integrated technical-methodical approach to visualise hydrological processes in an exemplary post-mining area in Central Germany. Photogrammetry and Remote Sensing, (in print).
- Großmann, J., 1996. Eingangsdaten und Parameter zur Berechnung der Grundwasserneubildung mit einem Einschicht-Bodenwasserhaushaltsmodell. In: DGM 40, pp. 204-221.
- Maniak, U., 1997. Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. Springer-Verlag, Berlin, Heidelberg.
- Scheuer, S., Thürkow, D., Gläßer, C., 2009. Ontologisches Web-GIS als Rich Internet Application Framework. In: FOSSGIS 2009. Proceedings zur Anwenderkonferenz für Freie

und Open Source Software für Geoinformationssysteme. 17.–19.03.2009, Hannover, pp. 153-160.

Sauter, M. A., Sauter, H., Bender, H., 2004. Blended Learning. Effiziente Integration von E-Learning und Präsenztraining. München.

Thürkow, D., Gläßer, C. Kratsch, S., 2005. Virtual Landscapes and Excursions – Innovative Tools as a Means of Training in Geography. In: König, G., Lehmann, H. & R. Köhring: Tools and Techniques for E-Learning, International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XXXVI-6/W30, Proceedings of the ISPRS working group VI/1 – VI/2, June 01-03, 2005 Potsdam, Berlin.

USDA, 1986. Urban Hydrology for Small Watersheds. Technical Release 55, Washington DC.

URL 1: <http://mars.geographie.uni-halle.de/geovlexcms/golm/geoekologie/bergbaufolgen>

URL 2: <http://mars.geographie.uni-halle.de/geovlexcms/golm/hydrologie/hwentstehung>

CREATING SUSTAINABLE E-LEARNING CONTENT WITH eLML (eLESSON MARKUP LANGUAGE) AND XML

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Commission VI

KEY WORDS: eLML, E-Learning, Markup Language, XML

WORKSHOP CONTENT:

This workshop will offer participants an insight view into the open source eLesson Markup Language and help them to gain some basic knowledge about XML technologies. The workshop starts with a short introduction and some "hands-on" exercises with XML and XSLT, the technologies behind eLML. The following part will provide a theoretical introduction into the structure and functioning of eLML. Then participants will try to create their own e-learning lesson and transform them into various formats like HTML or PDF. The goal of the workshop is to get to know both the potential behind eLML and its tools. Course authors should be able to judge after the workshop where the use of eLML would be helpful and where it would be inadequate. XML skills are an advantage but not mandatory. We will work with free software only and use the tools and tutorials available on the eLML website www.elml.org. Technical Session on eLML with Hands-on-exercises

ERDAS Tools for Online Sharing of Geospatial Knowledge and Workflows

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KEY WORDS: Online sharing, Geospatial Information, Webinars, Geodata sharing and collaboration

ABSTRACT:

ERDAS Inc. is using e-learning and e-collaboration technologies in 2 ways:

- a) For regular communication and knowledge sharing with its worldwide customers and
- b) As commercial-off-the-shelf products (ERDAS TITAN product suite) for building instant and secure Geodata sharing and collaboration platforms.

Since mid 2008, ERDAS offers regular, free, interactive and workflow-oriented webinars to its global customers and the Geospatial community. These 1-hour events are interactive sessions based on Cisco WebEx technology, which allow various forms of interactions between presenters and the audience. ERDAS also provides a comprehensive archive of these webinars for users to access on-demand from www.erdas.com.

ERDAS TITAN is a powerful geospatial data sharing infrastructure that enables users to publish their “top drawer” data to anyone else across the network, without shipping gigabytes of data in a bandwidth intensive manner. The ability to quickly discover and visualize what collaborators within a community of interest are doing is critical for an organization to be nimble and address issues in a time dominant and secure manner. ERDAS TITAN provides a 3D virtual globe, which allows users to create content and data mash_ups that can be quickly published and viewed by others.

1. INTRODUCTION

Traditional e-learning can be regarded as online training courses that enable attendees to subscribe, read and perform their lessons and ultimately pass an exam. This is one way how e-learning can be seen.

Yet learning is also informing yourself. Information about new features from a software company for example. The way individuals inform themselves has changed quickly since the revolution of the Internet age, enabling users to utilize the latest technologies instantaneously.

A modern company providing tools to author, manage, connect and deliver geospatial information also uses the latest technologies to deliver the information on their products, as well as provide a solution to easily share and work collaboratively with geo information.

ERDAS Inc. is doing just this.

2. WEB TOOLS

For ERDAS Inc., a company providing geospatial business solutions, it is crucial to provide the latest information about their products to the users. This could be:

- Information about new releases
- Information on latest functions
- “How to use” information
- Examples and use cases
- And many more ...

The Internet makes it possible to provide information that is more complex to users. Herby, new technologies are made available and information transfer is employed.

ERDAS uses the following:

- Webinars,
- Online forums and user groups (Twitter, YouTube, LinkedIn, etc.)
- Websisodes on ERDAS TV
- Blogs
- Traditional Newsletter

All these new ways of sharing information helps to bring ERDAS, its products, and the knowledge of how to use the software to the ERADS user community.

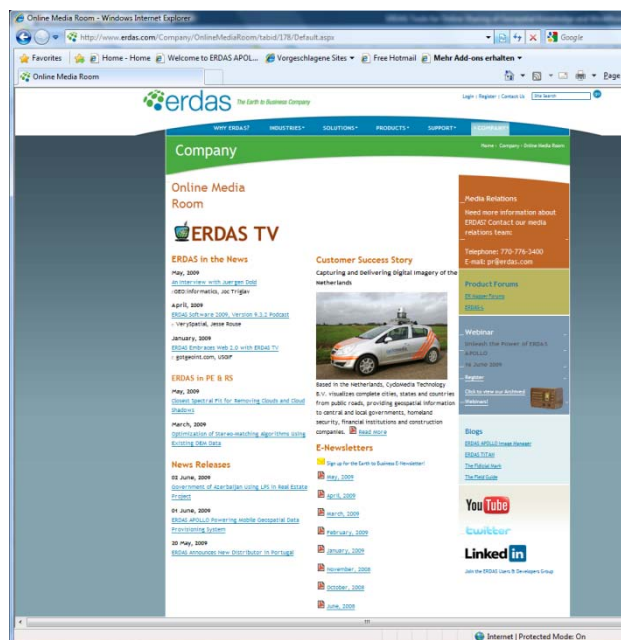
Webinars provide trainings with a two-way communication to a connected group of interested people. Typically, ERDAS uses this medium to inform their users about new functionalities or workflows. The webinars allow us to reach a much wider audience than giving live demos on site.

The online forums extend the more commonly used online newsletter allowing direct feedback from the group.

ERDAS TV brings real demos and explanations about the company, the work at ERDAS (inside look into the engineers development room) and of course information on the software products itself, about their usage and new features to the consumers.

For the major product lines, the product managers have setup blogs to inform the user community about features of interest. This could be something like tips & tricks to use the software, or even the publication of an ERDAS spatial model that can be used in ERDAS IMAGINE.

The blogs and all the other online information sources are available at one centralized location on the ERDAS website, within the online media room.



<http://www.erdas.com/Company/OnlineMediaRoom/tabid/178/Default.aspx>

2.1 Webinars, in more detail

The webinars will be described in a bit more detail, as it will show how easy it is to give and attend a live and online, remotely connected presentation or training session.

To attend an ERDAS Webinar, a user simply needs a computer and an Internet connection. The presenter will need an account at an online meeting service like CISCO

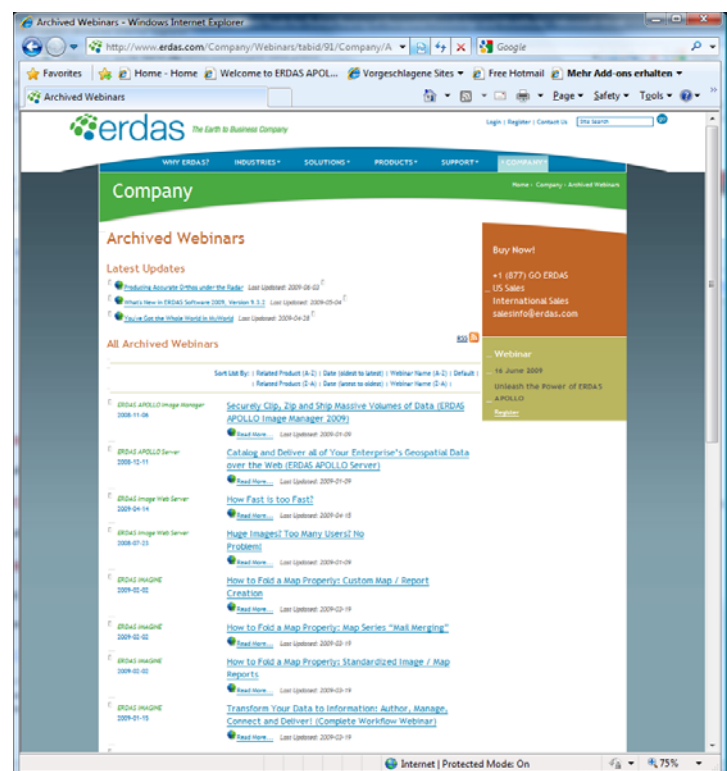
WebEx, which ERDAS is using. Cisco WebEx combines real-time desktop sharing with phone conferencing.

The host can setup an online meeting very easily in just a few minutes. He can define if a password to access the online meeting is required or if it is a public meeting. An email can be sent automatically to the invited attendees.

The attendee can just follow the link on the invitation to get to the registration site for that meeting. A registration is optional and can be defined by the host of the meeting. Contact details can for example be requested and stored to be able to address the attendees later on. After registration, the attendee just clicks on the "join the meeting" button to be placed directly in the meeting.

Depending on the settings, the host selected for voice transmittal, a notice with the details of the phone conference to be used or an integrated Voice Over IP (VOIP) option will be shown. After the user makes his choice, his name appears in the participant list along with a symbol, showing if he is using the phone line, the VOIP or if he/she is on mute.

Of course, there is an option for the host to record the session. Those that could not attend the webinar have a chance to access the recording later. ERDAS records all of its webinars. This archive can also be accessed from the ERDAS main web site.



Archived Webinars Site:

<http://www.erdas.com/Company/Webinars/tabid/91/Company/ArchivedWebinars/tabid/175/Default.aspx>

Another option during the meeting is to chat with other participants or with the host or presenter of the meeting.

Every attendee in the meeting can also be assigned as a presenter and other users can see the application or desktop, the actual presenter is going to share. This is useful if presenters are attending from different locations. This has been the case when ERDAS has presented news on the wide range of products, in which every product manager presents her/his products.

ERDAS is also using the Webex online meeting tools to work collaboratively on support cases with users of ERDAS software. Seeing what the user is doing, the error message and actually accessing the remote users desktop and applications speeds up the process of solving the support case. The user is then more satisfied and can get back to processing and extracting information out of his geospatial data.

3. SHARE AND COLLABORATE IN ERDAS TITAN WORLDS

3.1 What is ERDAS TITAN?

Once the user has processed his geospatial data and has extracted additional information, he might be interested to share his information in an easy way with other users, directly from his desktop. Alternatively, he wants to work collaboratively with other users in a 3D geospatial scene by creating a mesh up and share this with other users. All this can be done very easily within ERDAS TITAN, or better in a TITAN network. By sharing this information and working on it in a collaborative environment, ERDAS TITAN can also be seen as a Geospatial “E-learning product”.

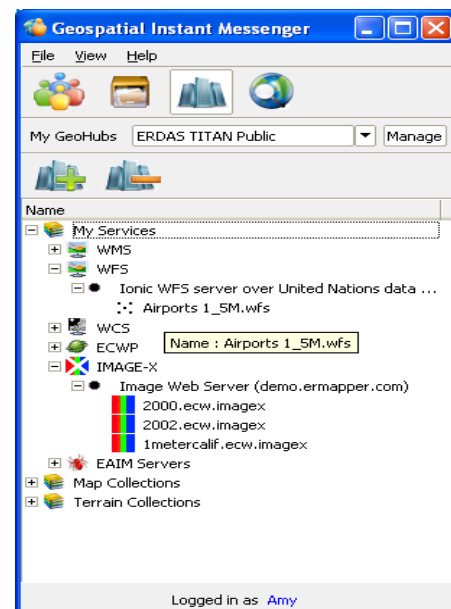
ERDAS TITAN is an innovative scalable, rapidly deployable, data sharing solution that maintains a secure environment and ensures protection of ownership rights. ERDAS TITAN empowers users and communities to share geospatial data, web services and location-based content internal and external to an organization, and to a variety of client applications. All subscribers in the ERDAS TITAN Network communicate and share data through the freely downloadable and distributable ERDAS TITAN Client. The free ERDAS TITAN Network is hosted by ERDAS Inc. and is only used for demos to show the capabilities of such a network.

The Geospatial Instant Messenger (GeoIM) enables users to chat, find, view and ultimately retrieve geospatial data and web services. TITAN enables permission-based publishing of data and content directly from desktops and laptops and ensures digital ownership rights are retained. Through the GeoIM, users publish data for others to access directly. Serving as the communication portal, the GeoIM enables authors and consumers of data to directly interact with one another. By addressing the social aspect of disaster data management, as a possible use case scenario for example, ERDAS TITAN promotes quicker decision making via

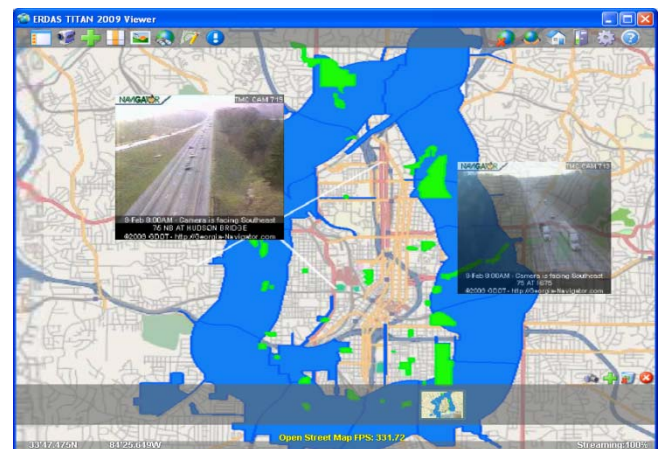
real-time communication and collaborating on projects. Using a 3D virtual globe, users can create data and content mash ups that can be quickly published and viewed by others. Users create a MyWorld, a geographically enabled personal space to upload their data, set permissions, and share content with other users in the network.

ERDAS TITAN also translates data on the fly to “view only” formats for consumption into a variety of other desktop, internet and 3D virtual globe applications.

The main two components for the user are the Geospatial Instant Messenger or ERDAS TITAN Client and the ERDAS TITAN Viewer. While the ERDAS TITAN Client acts as the “data bridge” to allow the consumption and publishing from a wide variety of data sources and formats to a wide variety of different clients, the ERDAS TITAN Viewer can be seen as the base tool to build 3-dimensional geographic scenarios and share them with their users for collaborative work.



ERDAS TITAN Geospatial Instant Messenger



ERDAS TITAN Viewer

In combination of our new technologies, ERDAS APOLLO Image Manager and ERDAS TITAN, both are tools for building SDI's and integrating with a Web based GIS into one frame work & dynamic sharing of geospatial information across the network. TITAN users can simultaneously broadcast one search query across multiple ERDAS APOLLO Image Managers, TITAN Network GeoHubs and local data. This can be done either directly from the TITAN Viewer or from the Geospatial Instant Messenger.

By using the TITAN Network, authors or owners of high-quality data can easily and securely supply their information to end users. Data consumers can readily explore data, combine information from disparate sources and view it via the applications of their choice. (Google Earth, Microsoft Virtual Earth and WMS compliant applications)

Components for a provider of an own TITAN Network, would be a TITAN GeoHub and a TITAN Master Server. The ERDAS TITAN GeoHub enables secure, permission-based data distribution for an entire organization. Organizations that employ a TITAN GeoHub and a TITAN Master Server can participate as a community on an own ERDAS TITAN Network. Multiple GeoHubs can exist in a TITAN Network. Users both internal and external to an organization may subscribe to a GeoHub, and a GeoHub Admin establishes individual and group data sharing permissions. The GeoHub is a caching proxy server: it processes requests for data from ERDAS TITAN Clients and acts as a conduit for the data flow between different users. The GeoHub also provides per-user, per-dataset security for all data shared via the GeoHub.

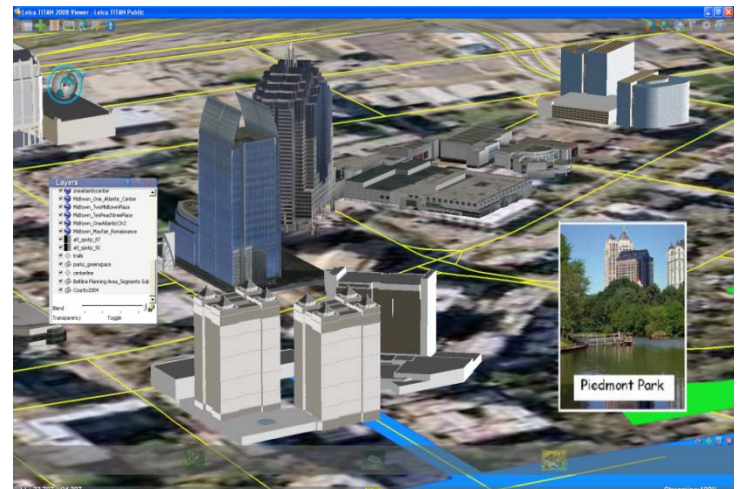
An ERDAS TITAN Master Server is the core of an ERDAS TITAN network solution, and is the master registry and management system. A Master Server allows you to implement a secure, autonomous network.

3.2 Workflow scenario

A possible workflow scenario, in which two or more users work collaboratively on one area of interest with different geospatial content and like that use ERDAS TITAN as a kind of e-learning solution, could be described by the following bullet point list.

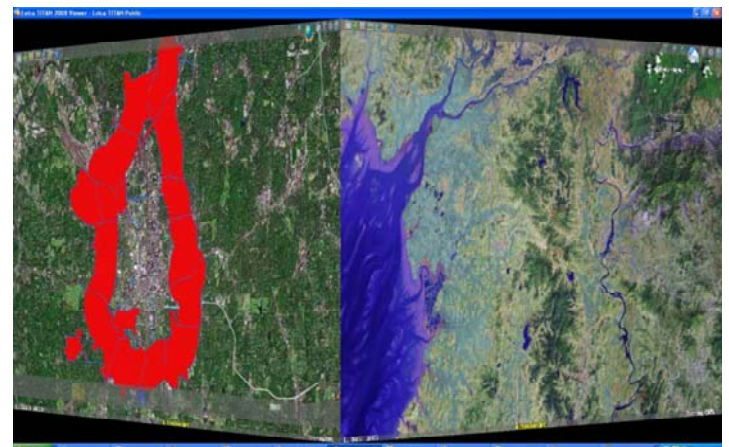
- Build a scene in the area of interest by using several imagery data of different type, format or projection
- Add terrain information to increase the resolution and accuracy of the base SRTM model provided via the ERDAS TITAN Master Server
- Add vector data, KML/KMZ models, define own symbology
- Data can also be consumed from other ERDAS TITAN users, and Web services provided through an ERDAS APOLLO solution or imagery data provided by a uniquely fast ERDAS Image Web Server

- Users build 3D interactive presentation spaces (MyWorlds) with geospatial data and location-based content and enable other users to interact in those spaces. The final scene or Mash up local data, data consumed from others, web services, location-based content can also be saved in local scene files. These local scene files can be load back into the Viewer at any time.



AN ERDAS TITAN user MyWorld Mash Up

- By switching worlds in the Viewer, the 3D globe rotates allowing you to interact, navigate and overlay local data in another user's MyWorld. Therefore, a second user can access the "MyWorld" of user A, who just created that one, can change data or add own content.



Switching to another users MyWorld

Like this, ERDAS TITAN allows in an easy and fast way to understand specific scenarios or projects easier. It helps to make decisions more efficient and helps to let remote connected people learn faster by using collaboratively geospatial information of a specific area.

For more information about ERDAS TITAN 2009 and the ERDAS TITAN Network, or to download the free ERDAS TITAN Client, please visit: www.erdas.com/TITAN.

4. CONCLUSION

There are a growing number variety of online media, sharing and collaboration options available that technology companies should utilize. Younger consumers of Internet applications learn fast and quickly adopt “Internet Tools” for sharing information. A wide user base defines a standard. A company that wants to reach the widest spread of information has to use blogs, online communities, video publishing and webinars.

The newest marketing initiative of ERDAS Inc., the ERDAS labs (<http://labs.erdas.com>), even allows the users to communicate back their ideas about, upcoming developments with the potential to influence feature development and implementation in new releases.

ERDAS TITAN is a scalable, rapidly deployable, dynamic data sharing solution, supporting data publishing and delivery into many geospatial applications. TITAN enables the data collector/creator in the field to create data, connect via air card and share data publicly or privately with thousands of other users. Publishing and accessing data with TITAN is much faster than standard, file-transfer modes, and even huge images can be quickly published, viewed and utilized by others. TITAN eliminates wasteful redundancy in data storage; data are streamed and users do not need to download files to view data.

Users consume data from a variety of public and private sources and into a variety of virtual globe, internet and rich client applications. TITAN is a “universal translator” enabling virtually any geospatial data to be published and viewed in a multitude of 2D and 3D geospatial viewers, such as Google Earth, Microsoft Virtual Earth, ERDAS IMAGINE, ArcMap, ArcGIS Explorer, MapInfo, GeoMedia, AutoCad and more.

TITAN enables near “real time” shared viewing of a common operating picture vital to effective communication during an emergency response. Users create their own “mash-ups” instantly with the ease of drag and drop. TITAN also provides a virtual globe experience where users create an interactive 3D presentation space, a ‘MyWorld’, with location-based content and geodata. With the click of a button, a MyWorld can be published to and navigated by other users on the Network. This enables multiple remote users to simultaneously view and understand the same common picture.

5. ABOUT ERDAS INC.

ERDAS – The Earth to Business Company – helps organizations harness the information of the changing earth for greater advantage. ERDAS creates geospatial business systems that transform our earth’s data into business information, enabling individuals, businesses and public agencies to quickly access, manage, process and share that information from anywhere.

Using secure geospatial information, ERDAS solutions improve employee, customer and partner visibility to information, enabling them to respond faster and collaborate better. It also means better decision-making, increased productivity and new revenue streams.

ERDAS is a part of the Hexagon Group, Sweden. For more information about ERDAS or its products and services, please call +1 770 776 3400, toll free +1 866 534 2286, or visit www.erdas.com.

E-LEARNING WITHIN A PRACTICAL INFIELT INDUSTRY

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Commission VI

KEY WORDS: E-Learning, Blended Learning, Training

ABSTRACT:

One of the biggest problems Trimble faces in training today is timeshare. Although Trimble sells infield and office software and hardware, it is the infield software and hardware that has the greatest number of users and is where the greatest volume of training is required. Today the majority of companies do not wish staff to attend training and be out of the office for more than two days. This presentation explains how Trimble has used, uses and would like to use eLearning to create a blended learning approach to solve this problem and ensure the same level of education is obtained that is more flexible and cost effective.

DISTANCE LEARNING - VISIONS, CHALLENGES AND REALITY

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Commission VI, WG VI/1-2

KEY WORDS: distance learning, education, UNIGIS

ABSTRACT:

With distance education in many disciplines increasingly moving from the ‘experimental and fringe’ stages towards a more established existence as a mainstream option in the mix of educational offerings available to students, the author discusses experiences from the worldwide UNIGIS program, from EU-sponsored joint curriculum development programs and from various outreach initiatives addressing very diverse student audiences.

While (nearly) pervasive access to online learning opportunities is greatly improving the accessibility of education, several critical factors will be addressed in this presentation:

- (1) Differentiate target groups: distance education is of particular importance to non-traditional target groups like in-service professionals, expatriates and mobile learners etc., but also students of institutions in peripheral locations. Prior knowledge, learning cultures etc compound the variety of educational situations distance teachers are confronted with.
- (2) Establish online learning environments: learning platforms today offer a wide range of content management and access as well as communication facilities. Matching these with pedagogical paradigms, learning strategies and the target group’s constraints is mandatory.
- (3) Develop a communication strategy: learning should be considered a social activity, it is helpful for most learner types when the ‘social fabric’ of a class is re-created online. As a challenge to ourselves: ‘communication is more important than content’ - ?
- (4) Schedule for success: particularly in part-time distance education, completion rates sometimes leave much to be desired. Supporting students in their balance of job, family, social live and learning is a critical factor for reaching graduation.
- (5) Virtual universities for real-life qualifications: the traditional model of distance learning originated from a highly centralized framework, and currently is evolving towards a distributed model challenging the management of educational institutions.
- (6) International education: students’ expectations, backgrounds, prior skills and knowledge, emphasis on education, teacher-student relationship and many other factors differ substantially worldwide. International distance learning programs thus face particular challenges.
- (7) Quality management: especially when reaching out to international audiences, traditional institutional educational QA needs to be enhanced by measures addressing the operational and management characteristics of distributed education.

Like in many other areas, it seems that in education the only constant is change as well. Transferring experiences, assumptions, organizations and mindsets from a centuries-old academic education framework towards a fully connected information and knowledge society requires some innovative thinking, courageous experimentation, and a lot of learning by all teachers.

EXPERIENCE-BASED LEARNING AND E-LEARNING: A PERFECT COMBINATION

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KEY WORDS: surveying education, experience-based learning, e-learning, natural resource management

ABSTRACT:

The discussion on the changing nature of the surveying profession has been a key issue for more than a decade. University and training institutions have been looking for new ways to respond to these changes. E-learning is playing a key role in the professional education of surveyors and future land professionals.

E-learning is also part of the education strategy of the International Institute for Geo-information Science and Earth Observation (ITC), Enschede, The Netherlands. E-learning has been introduced successfully in distance education and in distance MSc supervision. However activities to promote the use of e-learning in face-to-face courses at ITC have been disappointing, except for one course: the Natural Resource Management Module. This module differs from all other courses at ITC, in the fact that it is based on experience-based learning principles. Through its interactive and reflective nature the NRM Module is constantly adapting to new realities and changing directions in the professional field, and new educational tools and techniques, including e-learning, are easily taken up and integrated. Online communication and collaboration tools and the use of a virtual learning environment have proven to support in an unexpected way the learning process in the NRM Module. The analysis of personal experiences with moderating for many years the NRM Module shows that experience-based learning and e-learning are a perfect combination.

1. INTRODUCTION

1.1 Changing surveying profession

The discussion on the changing nature of the surveying profession has been a key issue for more than a decade among the members of the International Federation of Surveyors (FIG). Many experts in the field have expressed their concerns, analyzed the issue and developed new insights on the nature of the surveying profession and practice (Enemark, 2002; Mahoney et al, 2007, Osskó, 2008, Newnham, 2009).

Developments in ICT have had a huge effect on the profession (Markus, 2008). New technologies and new opportunities have enabled surveyors to broaden their skills and competencies. The number of competencies in which surveyors might claim to be proficient now number over 200 (Mahoney et al, 2007). It has created a growing need for continuous changes in education and an increasing demand for continuing professional development (Markus, 2008).

Enemark (2007) summarizes the major key international trends in the surveying education as follows:

- Management skills, versus specialist skills
- Project organized education, versus subject based education
- Virtual academy, versus classroom lecture courses
- Lifelong learning, versus vocational training

Fairly (2009), advocating a clear, concise surveying profile for the future, distinguishes two major changes taking place across Australia and the EU: internationalization and interoperability. Surveyors of today work in an increasingly global market and the profession has grown rapidly beyond cadastral surveying, with increasing application of surveying and mapping technologies in other sectors.

1.2. Educational responses

University and training institutions have been looking for new ways to respond to these trends in the surveying profession and the challenges they represent. Curricula have been developed based on new educational approaches and tools, like problem-based learning (Enemark, 2002, 2004, 2007, Álvarez et al, 2006), outcome-based learning (Lam & Chan, 2007), blended-learning (Stavova et al, 2007), experiential learning (Grover 2008, Culliver 2008), business models (Markus 2008, Culliver, 2008), studium fundamentele (Sternberg and Krebs, 2008), Crossroads (Stempel, 2007).

Lifelong learning has become a buzz-word and a well established concept for continuous professional development of staff engaged in surveying institutions and other land professionals (Osskó, 2008). The Bologna Process and exchange programs such as ERASMUS have opened up educational borders in Europe. Mutual recognition of surveying qualifications will open up international benefits to the surveying community (Fairlie, 2009).

E-learning methods and tools have been introduced and are now playing an increasing role in professional education.

2. E-LEARNING

2.1 E-learning and FIG

E-learning is one of the main themes in FIG Commission 2 - Professional Education (Markus, 2008). The commission is working on the development of an FIG publication on e-Learning in surveying to bring together the experiences and viewpoints within FIG on the role of e-learning in surveying education (Markus and Groenendijk, 2009).

Markus (2008) defines e-learning as follows: "... e-learning is a learning process created by interaction with digitally delivered content, network-based services and tutoring support. This definition focuses on the revolutionary impact of network-enabled technology. Adding more details on methodology: e-learning is any technologically mediated learning using computers whether from a distance or in face to face classroom setting (computer assisted learning), it is a shift from traditional education or training to ICT-based personalized, flexible, individual, self-organized, collaborative learning based on a community of learners, teachers, facilitators, experts etc."

Central in this definition are to aspects of e-learning:

- E-learning as computer assisted learning
- E-learning as a pedagogy for student-centred and collaborative learning

2.2 E-learning at ITC

At the International Institute for Geo-information Science and Earth Observation (ITC) e-learning has been promoted since 2001. In order to cope with the changing demands for education in the field of geo-information science and earth observation, two basic strategic have been developed: decentralisation of education and part-time education. In both strategies distance education and e-learning are seen as valuable and indispensable instruments.

The first project on distance education and e-learning (2001-2004) mainly focussed on the introduction of a digital learning environment and its implementation in the ITC's education processes. A second e-learning project (2005 – 2008) placed much emphasis on the development of multi-usable courseware and distance education courses. The activities of this project group are organized in six working packages (Box 1).

Central in the activities of the project e-learning at ITC is the development of multi-usable courseware. The term "multi-usable courseware" is used at ITC to refer to (digital) learning materials that are suitable for use in different teaching modalities such as face-to-face education, distance education and joint courses. Verkroost (2009) describes in more detail the experiences with multi-usable courseware and the re-use of courseware in different teaching settings.

The six working packages of the project e-learning (2005-2008)

1. Courseware development for Distance Education Courses
2. E-support to joint courses
3. Supervision of thesis at a distance
4. E-learning in F2F courses at ITC
5. Staff development
6. Coordination of Distance Education and E-learning

Box 1. Working packages of ITC's project e-learning

2.3 E-learning and face-to-face teaching

While most of the working packages were successful in their implementation, working package 4, e-learning in face-to-face courses at ITC, experienced major difficulties in achieving its goals. The concept of multi-usable courseware in curriculum working groups at ITC is non-existent and the use of e-learning got very little support from lecturers engaged in classroom teaching. One module however has integrated e-learning methods and tools quite naturally and successfully in its programme: the introductory module of the Master of Science Degree and Postgraduate Diploma Course in Geo-information Science and Earth Observation for Natural Resources Management. The Natural Resource Management Module, the so-called NRM Module, differs from all other courses at ITC, in the fact that it is based on experience-based learning principles.

3. EXPERIENCE-BASED LEARNING

3.1 Definition

Experience-based or experiential learning is defined as the process whereby knowledge is created through the transformation of experience (Kolb, 1984).

The knowledge and the professional experiences of the students are seen as an important source of learning. Students learn from systematic reflection on what they do individually and inside a training group

3.2 Experience-based learning and the NRM Module

The NRM Module has a history dating back to 1993. At that time ITC was offering several separate courses in the field of natural resource management. The management of the institute recognised the importance of a multi-disciplinary approach towards natural resource management and how could this be better promoted than in a common introductory module for these courses?

In this module also basic professional and academic skills such as critical thinking, independent learning, presentation and communication skills, reading and writing skills are considered to be essential learning objectives.

Considering the aim and objectives of the module and the particular target group, the Spiral Model of Learning methodology (FMD Consultants, 1993) was selected for this module. This student-centred training methodology is based on the principles of experiential learning and is in particular applicable for adult education.

Most of the training is based on exchange, analysis and systematization of students' experiences. This means starting with the student and working with the experiences they gained in their organisation and actual working situation, and in a training setting.

In the Spiral Model of Learning the education process is organised in a six-stage cycle involving six adaptive learning modes – initial expectation and readiness, description of experiences, diagnosis and reflection, conceptualisation, experimentation and practice, and integration and action planning. Each of these stages requiring a series of individual or group exercises.

3.3 The Spiral Model of Learning

In the following paragraphs the different steps of the Spiral Model of Learning are explained and illustrated with practical examples of learning exercises from the Natural Resource Management Module.

3.3.1 Initial expectation and readiness: The learning process starts with the expectations of the students about the course. These are presented and compared with course objectives, and differences are discussed to reach a shared learning perspective. The training process is clarified for a clear and shared understanding of how learning is organised.

To stimulate favourable learning conditions, emphasis is on developing an open atmosphere of mutual respect, trust and commitment within the group. Students are stimulated to play an active role in the learning process: e.g. students are responsible for the daily reporting, and animation and socialising.

3.3.2 Description of students' experiences: In this step the present knowledge and experiences of students within their working context is analyzed and systematized. Students are stimulated to describe their knowledge and experiences through a series individual and group exercises:

- To express their knowledge and ideas
- To reflect their working experience and practice
- To reflect on their regular working behaviour or attitude
- To describe their working or institutional context

A central part of learning is that individual experiences are being expressed, discussed and compiled for further brainstorming in the group (fig. 2). Various exercises are developed to explore students' perceptions on Natural Resources and Natural Resources Management. This is followed by a series of progressive exercises analysing working experiences.



Figure 2. Students of NRM Module 1, 2006, discussing success and failure factors in their professional work.

3.3.3 Diagnosis and reflection on experiences: Students systematically compare their a priori ideas of their situations with the emerging picture of actual practices and conditions under which these practices develop. Such a comparison leads to the identification of gaps between their actual (what they really do) and desired situations (what they think they do). It enables the students to evaluate their role in the past and motivates for further learning.

Based on the diagnosis of students' experiences, gained in the earlier steps, the key issues and problems in Natural Resource Management are identified. This is a crucial step in the learning process as these issues will further guide the continuation of the learning process.

In 1993 the following key issues in natural resource management were identified by the students: Participation, Multi-disciplinarily, Sustainability and Spatial variability; in 2008 one of these issues is still relevant, sustainability, but others have been replaced by more actual concerns in their professional practice: like Competition and Conflicts, and NRM in the International Context.

3.3.4 Conceptualisation and analysis: Only at this stage new theories and experiences from external sources are being offered to the students in the form of special lectures, reading assignments, reflective exercises, internet searches, or videos. The key issues identified in earlier stages are now further studied.

The main elements for a framework for a multi-disciplinary approach in NRM are developed, the emphasis of which on the role of geo-information in NRM. Central to the approach is the interconnection between the key issues identified. This will create a new understanding of the role of surveying and geo-information within NRM. The continuation of the course fits into this initial conceptual framework of NRM developed based on the experiences and realities of the students.

3.3.5 Analysis, experimentation and practice: The students gain more insight experiment the concepts and developed approach during a fieldtrip. Under field conditions they validate their new insights and approach, which contributes to further learning and consolidation of concepts. Trained skills in earlier modules are applied and gained insights are being tested.

At this stage students have developed an independent working attitude, are competent to guide and work in teams, and feel confident to bring in their ideas and concepts. Students are responsible for the planning, organization and reporting of a one-day fieldtrip.

3.3.6 Integration and action planning: The concepts and approaches developed in the introductory module serve as a framework for the remaining part of the course. Regular moments of reflection on the learning progress throughout the course are organized in which the learning experiences of the students are integrated in this overall framework.

At the final stage of the course, students prepare themselves for the implementation of the developed framework in their own working situation: the training spiral is becoming a full cycle.

4. EXPERIENCE-BASED LEARNING AND E-LEARNING

The structure and basic exercises of the NRM Modules have remained more or less unchanged during the years. Nevertheless, through its interactive and reflective nature, the NRM Module is constantly adapting to new realities and changing directions in the professional field. Not only the content of the module is subject to changes, also new educational tools and techniques, including e-learning, are easily taken up and integrated (Groenendijk, 2009).

Blackboard has been introduced for all courses at ITC in 2001. In fact this supported very much the learning activities in the NRM Module, in particular through its communication and collaboration functionalities such as group pages, discussion boards, home pages and announcement board.

Throughout the module students become more confident to take responsibility for the learning process. Students bring in their computer skills to organise their working groups, to develop interactive presentations and creative ways of reporting. This has resulted in the introduction of unexpected digital tools which turns out to support the learning much better than the original methods used in the exercise.

The e-change in the Natural Resource Management Course Some examples		
Learning object	Learning methods	
	1993	2008
Students introductions	Pair-wise interviewing and world map	Presentations with Google Earth and You Tube; Students create own homepage in Bb
Daily Reporting	Hand-written reports; compiled at the end by secretary	Interactive Power Point presentations; uploaded in group pages in Bb; Discussion board in Bb; Wiki for interactive and progressive glossary development
Rules of learning	Group rules on written sheet.	Group rules on printed poster including pictures of group members; Poster exposed in the class for entire course.
Students' institutional working background and NRM	Based on (annual) reports of organisations (if available)	Use of student's organisation website for detailed information and country case studies
Information skills	Introduction in the library	Digital library training Use of digital library
Introduction Sustainability	The Nuts Game, experience-based learning game	Still the Nuts Game, but also Online quiz Your Ecological Footprint (http://www.footprintnetwork.org/)
Various exercises involving critical reading on identified NRM Issues	Use of copies of articles; handouts	Use Blackboard and internet library searches; Websites of major international organisations FAO, WB, UNEP
Resources, Actors and Objectives	Analysis based on sketch maps	Sketch maps combined with Google Maps
Field excursion planning and implementation	Topographic maps, aerial photographs	Application of ArcGIS; GPS and PDA for planning and recording; digital cameras
Field excursion reporting	Oral presentations by each group	Diversity of reporting modes: Presentation (PowerPoint), article local/NGO magazine; Poster; GPS Nature Walk for use by NGO

Table 3. Overview of e-change in the NRM Module, 1973 and 2008.

Successful tools are integrated in the course and used in the next courses. Examples of these innovations introduced by students: use of You Tube during student introduction, Wiki for Glossary development, and the Nature Walk as a form of reporting making use of Google Earth. The overview in Table 3 is an attempt to show how e-learning tools have become part of the learning methods and enriched the learning process.

E-learning and the virtual learning environment, in this case Blackboard, have increased dramatically the available number of educational tools and training challenges. And it seems as if they were developed to support experiential learning and particular in the NRM Module.

5. CONCLUSION

The Spiral Model of Learning approach applied in the NRM Module at ITC has been particularly developed for training of adult and mid-career professionals from mainly developing countries. It has proven to be an excellent educational approach to train surveying professionals with different working and cultural backgrounds.

Experience-based learning, and as applied in this case, the Spiral Model of Learning, promotes lifelong learning and fits the concept of continuing professional development. Each new individual training effort can be considered a loop in the spiral model of lifelong learning.

The typical nature of the experiential learning approach makes each module or course a new adventure. Changing realities in the professional field are brought in by the students and become the basis for further learning and developing the module or course.

E-learning and the virtual learning environment, in this case Blackboard, have increased dramatically the available number of educational tools and training challenges. Discussion boards, Wikis, Blogs, You Tube, Google Earth are typical examples for such tools and it seems as if they were developed to support experiential learning.

Online communication and collaboration tools and the use of a virtual learning environment, Blackboard, have supported in an unexpected way the learning process in the NRM Module. Based on my experiences as a course facilitator of the NRM Module for many years I can only conclude: experience-based learning and e-learning are a perfect combination.

If e-learning is expected to play a mayor role in face-to-face teaching at ITC, and other surveying training institutions, then it is recommended to further explore the potential of an experience-based pedagogy for new curricula to be developed.

6. REFERENCES

Álvarez, M.F., M. Fernández Martínez, J.R. Rodríguez-Pérez, E. Sanz Ablanado (2006). Problem Based Learning (PBL) and e-learning in Geodetic Engineering, Cartography and Surveying education in the European Higher Education Area

(EHEA) frame. A case study in the University of León (Spain). Proceedings XXIII FIG Congress Shaping the Change, 8-13 October, 2006, Munich, Germany.

Frank Culliver (2008). Training the Generations for Business Success. Proceedings FIG Working Week Integrating Generations, 14-19 June 2008, Stockholm, Sweden

Enemark, S. (2002). International Trends in Surveying Education. Proceedings FIG XXII International Congress, 19-26 April, Washington, D.C. USA.

Enemark, S. (2004). Building competences of the Future. Designing and Implementing a New Curriculum in Surveying at Aalborg University, Denmark. Proceedings 3rd FIG Regional Conference, 3-7 October 2004, Jakarta, Indonesia.

Enemark, S. (2007). Promoting the interaction between education, research and professional practice. Proceedings FIG Commission 2 - Symposium, Scientia est Potentia - Knowledge is Power, 7-9 June 2007, Czech Technical University, Prague, Czech Republic.

Fairlie, K. (2009). Navigating the global consciousness: a young surveyor's future. Proceedings FIG Working Week, Surveyors key role in accelerated development, 3-8 May 2009, Eilat, Israel.

FMD Consultants (1992). The Spiral Model of Learning Training Methodology. Working Document.

Groenendijk, E.M.C. (2009). Experience - based learning in the geo-information sciences: 15 years of nuts game. Proceedings FIG International workshop, Navigating the future of surveying education, 26 – 28 February 2009, Vienna, Austria.

Grover, R. (2008). Developing Quality Training Approaches for Effective Property Tax Administration. Proceedings FIG International Workshop Sharing Good Practices: E-learning in Surveying, Geo-information Sciences and Land Administration, 11-13 June 2008, Enschede, The Netherlands.

Kolb, D. A. (1984). Experiential Learning. Experience as the source of learning and development. New Jersey, Prentice-Hall, Inc.

Lam, S. Y. W. and A. P. C. Chan (2007). Sustainable Curriculum for Geomatics Higher Education. Proceedings FIG Commission 2 - Symposium Scientia est Potentia - Knowledge is Power., 7-9 June 2007, Czech Technical University, Prague, Czech Republic.

Mahoney R., F. Plimmer, J. Hannah and J. Kavanagh (2007). Where are we heading? The crisis in surveying education and a changing profession. Proceedings FIG Working Week 2007, Strategic Integration of Surveying Services, 13-17 May 2007, Hong Kong, China,

Markus, B. (2008). Thinking about e-Learning. Proceedings FIG International Workshop. Sharing Good Practices: E-learning in Surveying, Geo-information Sciences and Land

Administration, 11-13 June 2008, ITC, Enschede, The Netherlands

Newnham, L. (2007). Surveyors – land professionals, adventurers, pioneers and now entrepreneurs? Proceedings FIG Working Week, Strategic integration of surveying services, 13-17 May 2007, Hong Kong, China,.

Osskó, A. (2008). The importance of changes in land surveyors' education. Proceedings FIG International Workshop. Sharing Good Practices: E-learning in Surveying, Geo-information Sciences and Land Administration, 11-13 June 2008, ITC, Enschede, The Netherlands.

Šťávoň Z., V. Pechanec and V.Voženílek (2007). A blended Learning Course for Thematic Cartography, pg. 155 – 165. Proceedings FIG Commission 2 – Symposium Scientia est Potentia – Knowledge is Power, 7-9 June 2007, Czech Technical University, Prague, Czech Republic

Sternberg, H. and C. Krebs (2008). New perspectives for Geomatics Bachelor and Master Education at the HafenCity University Hamburg. Proceedings FIG Working Week. Integrating Generations, 14-19 June 2008, Stockholm, Sweden.

Verkroost, M.J. (2009). From multi-usable courseware to a multi-usable pedagogy. Proceedings ISPRS Workshop Commission VI/2 V12, E-learning Tools, Techniques and Applications, 17-19 June, 2009, Potsdam, Germany.

FROM MULTI-USABLE COURSEWARE TO A MULTI-USABLE PEDAGOGY

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KEY WORDS: Teaching, online, design, development, requirements

ABSTRACT:

The International Institute for Geo-information Science and Earth Observation (ITC) in the Netherlands started developing and implementing e-learning ten years ago. A project was set up to manage this. An important starting point has been the concept of “multi-usable courseware”. Multi-usable courseware is defined as (digital) learning materials which are suitable for use in different teaching modalities such as face-to-face education, distance education and joint courses. It is assumed that developing multi-usable courseware will lead to a more efficient process of developing education and to higher quality teaching and learning materials. The experiences with developing and using multi-usable courseware at ITC lead to new insights about this concept. The development of multi-usable courseware out of a distance education perspective has been more successful than the development out of a face-to-face perspective. The teaching modality of distance education makes it necessary to make educational materials suitable for independent study. These materials are quite easy to use in face-to-face or other modalities of education. However, students only experience the benefits of using these materials when the pedagogy in the face-to-face teaching modality is changed away from the traditional lecturing setup. Cases in which the distance education materials were used in face-to-face education with a setup in which the number of lectures was decreased and the lectures changed in nature to more discussion sessions have been successful. The conclusion of this study is that it is better to start thinking about a pedagogy which is multi-usable then to start with developing multi-usable courseware. When the context, the pedagogy, is multi-usable the development of multi-usable courseware will follow automatically.

1. INTRODUCTION

The use of learning materials in different teaching settings is a natural part of most teachers’ working method. When teachers are faced with a new teaching task, they almost automatically start thinking about the learning materials which they already have and could be re-used. These learning materials are often the product of a long process of thinking and experience and worthwhile to be considered for use in another setting. The use of learning materials in different teaching settings is also efficient within the context of the often demanding teacher’s job.

The International Institute for Geo-information Science and Earth Observation (ITC) in the Netherlands has gained some experience with developing learning materials for use in different teaching settings through their e-learning project. The term “multi-usable courseware” is used at ITC to refer to (digital) learning materials that are suitable for use in different teaching modalities such as face-to-face education, distance education and joint courses. Figure 1 shows the concept of multi-usable courseware.

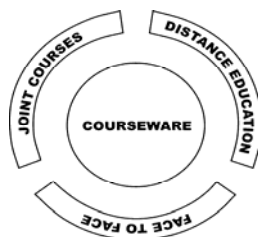


Figure 1. The concept of multi-usable courseware

In literature, the re-use of courseware or learning materials is discussed in the context of the re-use of “learning objects”. Learning objects are defined as “any digital, reproducible and addressable resource used to perform learning activities or learning support activities, made available for others to use” (Koper, 2003). This definition excludes non-digital resources. In our study these are included in the definition because the textbook remains an important source of information in our educational practice. Many publications on learning objects focus on the technical aspects of learning objects: ontology, standards and engines (Koper, 2006). This paper however focuses on the pedagogical aspects of learning objects.

Laurillard and McAndrew (2003) address learning objects from a pedagogical point of view. They plead for the development of generic learning activities. These generic learning activities can be applied in different teaching settings and content areas. Their design should be based on a sound generic pedagogical framework, such as the Conversational Framework as developed by Laurillard (2002). The design of generic learning activities is a bottom-up process. Based on the generic pedagogical framework, an initial learning activity is developed, tested, refined and proven. The generic learning activity can be created by taking out the specific content and adding guidelines for use. Multi-usable courseware can be seen as generic learning materials, supporting generic learning activities.

ITC has used a bottom-up process to develop multi-usable courseware by monitoring several cases of re-use of courseware in different teaching settings and deducting generic principles for multi-usable courseware from these cases. These generic

principles will lead future courseware development at ITC and could be useful for other institutes facing the same challenge.

2. METHOD

A large number of data are brought together in this paper. Two types of data are distinguished: data on multi-usable courseware in general and data on specific cases in which distance education courseware is used in face-to-face education.

2.1 The ITC E-learning Project

ITC started developing and implementing e-learning ten years ago. A project was set up to manage this. The e-learning project has changed its focus over time based on experiences. In the beginning it is thought that multi-usable courseware can be developed for both face-to-face teaching situations and distance education. Money has been allocated to both distance education developers and face-to-face education curriculum development groups to develop multi-usable courseware. While the development of distance education increases in time, the attention for e-learning and multi-usable courseware in curriculum working groups at ITC is non-existent. This has led to a heavy emphasis on distance education development and the use of the distance education courseware in face-to-face education in the e-learning project.

2.2 Multi-usable Courseware in General

For gathering information on multi-usable courseware in general, two methods are used: a survey and interviews.

Survey on Multi-usable Courseware: In April 2008, a survey about multi-usable courseware is addressed to 32 ITC staff members of whom it is known that they have been or are involved in distance education at ITC. 17 staff members respond to the survey. The survey consists of 25 questions, spread over 4 sections:

Background information:

- Involvement in teaching and developing distance education.
- Teaching the same topic in face-to-face and distance education manner.

The use of face-to-face educational materials in distance education:

- The extent and manner of using face-to-face materials in distance education.
- Required changes of the face-to-face materials.
- Experiences with using the materials in distance education and plans for future use.

The use of distance education materials in face-to-face education:

- The extent and manner of using distance education materials in face-to-face education.
- Required changes of the distance education materials.
- Experiences with using the materials in face-to-face education and plans for future use.

Multi-usable courseware in general:

- The possibilities of designing education material which can be used in different teaching settings, such as face-to-face, distance education and joint courses.

- The importance of designing educational materials in such a way that they can be used in different teaching settings.
- The aspects of educational or working practice of a teacher that influence whether education materials will be used in different teaching settings.

Interviews on Multi-usable Courseware: Four ITC staff members are interviewed in May 2008 on the idea of multi-usable courseware after the survey. These staff members volunteer for the interview in the last question of the survey. In the interviews, the following topics are addressed:

- Experience with and plans for designing and using courseware in different teaching settings.
- The value of the concept of multi-usable courseware
- Types of multi-usable courseware
- The e-learning project

2.3 Cases

Five cases of using distance education courseware in face-to-face education are described in this paper. Each case is built on different data sources, which are shown in Table 2.

Case	Method	Date	Respondents
Geographical Information Systems	Survey	November 2006	43 students
	Group interview	November 2006	2 student groups: 20 students and 11 students
	Article: Augustijn-Beckers et al. (2008)	June 2008	50 students
Remote Sensing	Interview	October 2006	1 teacher
	Group interview	November 2006	11 students
Spatial decision support systems	Article: Boerboom and Groenendijk, 2007	March 2007	1 teacher
Geostatistics	Survey	August 2008	11 students
	Interview	August 2008	1 teacher
Hyperspectral remote sensing	Survey	August 2008	11 students

Table 2. Overview of data sources for the five cases

These data sources address the following topics:

- The way that distance education materials are implemented in face-to-face education.
- Student and/or teacher experiences of using distance materials in face-to-face education.
- Student and/or teacher experiences with a pedagogy in which students study more independently.

3. MULTI-USABLE COURSEWARE IN GENERAL

This section describes the results of the survey among and interviews with ITC staff about multi-usable courseware.

3.1 The Concept of Multi-usable Courseware

All respondents to the survey think that it is possible and important to develop courseware in such a way that it can be used in different teaching settings. Motivations for this are: efficiency of development, higher quality of materials and the enrichment of learning with e-learning. Availability and allocation of time is necessary to make a choice for using educational materials in a different teaching setting.

The concept of 'multi-usable courseware' is directly related to the teaching setting and pedagogy. According to the interviewees, distance education courses and multi-usable courseware can only be developed for well-structured topics at a lower level of knowledge and skills which can be studied without much interaction with and feedback of others. It is recommended to develop standard formats and tools for courseware types which are considered multi-usable in nature to reach uniformity.

3.2 Use of Face-to-Face Courseware in Distance Education

Distance education courses at ITC often contain courseware from face-to-face education. This courseware consists mainly of PowerPoint presentations, assignments and exercises, articles and books or readers. The courseware from face-to-face education is used in distance education with rather or very little change. The most common changes made in the courseware for use in distance education are: adding or improving explanations, making it suitable for use without supervision and changing the order or organisation of the courseware.

Most respondents to the survey are rather positive about the use of face-to-face courseware for use in distance education and plan to do this in future. Most suitable courseware from face-to-face education for distance education is: exercises and practical assignments, books and readers and PowerPoint slides.

According to the interviewees, PowerPoint slides are looked at first when teachers are looking for distance education courseware but they are less suitable for use in distance education than expected. They need to be adapted considerably by cutting them in chunks which can be handled by the learner and by adding animations and explanations.

Assignments are usable in distance education if they have a limited size and can be conducted without the presence of a supervisor. They should start with an introduction and be worked out from simple to complex using a step-by-step approach and giving examples. Feedback on the assignments can be given by the teacher or by peer students.

According to the interviewees it takes considerable time to make face-to-face courseware suitable for use in distance education. Sometimes it can even be a burden to already have face-to-face courseware.

3.3 Use of Distance Education Courseware in Face-to-Face Education

Distance education courseware is used in the regular programmes at ITC, and in short courses inside and outside ITC. Distance education courseware used in face-to-face education are mainly assignments, but also self-tests, and video recordings of fieldwork. This courseware is changed very little for use in face-to-face education. The experience with the use of distance education courseware in face-to-face education is rather to very positive and most respondents plan to do this again in future. Most suitable courseware from distance education for face-to-face education is: assignments and exercises, e-lectures, self-tests and videos.

According to the interviewees, distance education courseware is more explicit and better worked out into smaller learning units than courseware for face-to-face education. You need to think about your learning goals, content and assessment in advance because you cannot change things the last moment as is practice in face-to-face education. This leads to better quality courseware.

Some of the interviewees are involved in some of the experiments with the use of distance education courseware in face-to-face education. Teaching (part of) a face-to-face course in "distance education mode" is something which is not something to be done overnight. Students have to be prepared to work more independently and need time to get used to the idea. It should be introduced in such a way that students see it as an advantage to study this way, instead of negative behaviour of the teacher. Minimal, you can use the distance education courseware as an extra resource for enrichment. It is questioned whether students with a weak background and motivation will do well in more independent work.

4. CASES FROM FACE-TO-FACE EDUCATION

Five cases have been followed and evaluated by the e-learning project in which ITC distance education courseware is used in face-to-face education. These cases show in what extent distance education courseware can be considered as multi-usable. The cases are described below, focusing on the distance education courseware used in the face-to-face module and the matching pedagogy.

4.1 Geographical Information Systems (GIS)

The face-to-face GIS course uses GIS distance education courseware consisting of e-lectures (enriched Powerpoint presentations, accompanied with spoken or written texts), introduction videos, video-lectures (recorded lectures), self-tests, practical assignments and a study guide. The distance education courseware is used to let the face-to-face students study independently. The students are supposed to do a large amount of self-study, using the text book, video lectures and e-lectures. This self-study is accompanied by face-to-face "question and answer sessions". The question and answer sessions consist of a summary of the main thoughts in the learning materials by the lecturer and the possibility to pose questions to the lecturer. These questions can be posted in advance in the digital learning environment.

The face-to-face students experience the GIS distance education courseware as a nice addition to the text book; they are not seen as a replacement of face-to-face lectures. The students feel that they are able to study the distance education courseware by themselves, but they disagree on whether they like to study like this. The students have adapted to the pedagogy of independent study but most of them prefer traditional lectures where the topics are explained in detail.

Augustijn-Beckers et al. (2008) report on a study at ITC, comparing the needs and use of distance and face-to-face learners regarding GIS distance education courseware. The *text book* is used above average by both distance and face-to-face learners. The text book is considered more important for the learning process by face-to-face learners than by distance learners. *Video-lectures and e-lectures* are used more frequently by distance learners than by face-to-face learners. They are also considered to be of more value for the learning process by distance learners. E-lectures (Powerpoint presentations) are considered more valuable for learning than video lectures (recordings of a teacher during a lecture). The *self-tests* are used frequently by both distance and face-to-face learners and are of high value for the learning process of both types of learners for assessing individual progress. The *practical assignments* are equally used by both distance and face-to-face learners. However, the face-to-face learners value these exercises higher for the learning process than distance learners. The *study guide* is used more often by distance learners than by face-to-face learners, but they value the contribution to the learning process equally.

4.2 Remote Sensing (RS)

The face-to-face RS course uses a series of practical assignments from the RS distance education course. These assignments are developed in such a way that the student can work on them without the teacher being physically present. The assignments come originally from the educational programme at ITC but have been adapted for distance education purposes. The assignments therefore have a long history of use. In the face-to-face RS course the practical assignments are used to let students work independently during practical sessions.

The students are able to do the exercises well and use the answer sheets for standard feedback about the correct answer or to find out where they have made a mistake. Some students prefer to have a coach for the practical sessions who is permanent available for advice and tips in stead of answer sheets. The answer sheets can not replace the teacher totally. Therefore students would like to also have plenary meetings for tailor-made feedback by the teacher.

4.3 Spatial Decision Support Systems (SDSS)

The materials of the SDSS face-to-face course have been used as a basis for the distance education courseware, consisting of an introduction video, e-lectures (PowerPoint slide presentations with voice-over), and a software video demonstration. The e-lectures are developed from face-to-face lectures which are recorded, transcribed, edited and recorded again and linked to the related slides. This is a labour-intensive process which according to staff involved leads to a higher quality of their education materials.

The e-lectures are used in the face-to-face SDSS course. They give students the opportunity to study more independently and to revisit lectures or to catch-up in case of personal circumstances such as illness. The use of these materials by face-to-face students has led to more thoughtful questions and discussions according to the teacher.

4.4 Geostatistics

The face-to-face Geostatistics course uses text-based e-lectures from the Geostatistics distance education course. These text-based e-lectures include theory and exercises, and are used as a basis for the theory in the face-to-face course.

The pedagogy in the face-to-face course is directly linked to these text-based e-lectures. The face-to-face Geostatistics course is organized in such a way that students can study most of the time independently. Each of the first eight days of the course is spent on one topic. The days start with a lecture, followed by individual student work and are closed with a question and answer session. When all students have submitted the results of the exercise, the standard outcome is submitted to the digital learning environment for students to compare with their own outcome. The last seven days the students work on an individual case individually or in groups.

The lecturer has the strong impression that many students hardly study the e-lectures. He bases that impression on the type of questions he receives in the question and answer sessions. Students might think or hope that the lecture covers the essence of the topic and start to work on the exercise directly after the lecture (as is done in most modules where there is no time for self-study in between the lecture and the practical). The students comment positively on the quality of the e-lectures in the evaluation.

The students are positive about the independent learning method: the lectures explain the theory well, the number of lectures is according to standard, and the attention by staff is sufficient.

4.5 Hyperspectral Remote Sensing (HSRS)

In the face-to-face HSRS course the complete distance education course HSRS is used. The pedagogy from the distance education course is slightly changed to accommodate for the face-to-face situation, but the course is used more or less unchanged. The face-to-face course is organised in such a way that the student spends a lot of time studying independently with the courseware from the distance education course. The staff organizes three face-to-face meetings per week in which an overview of theory is given and group discussions are held. They adapt this from the distance education mode of teaching because students expect to see their teacher when they are studying here at ITC.

The students evaluate the pedagogy of independent study well: the theory is sufficiently explained in the lectures, there is enough help from staff and the amount of self-study time is okay.

5. CONCLUSIONS AND DISCUSSION

The concept of multi-usable courseware is a powerful concept which is important to pursue for reasons of efficiency, quality and

flexibility. The experiences in the cases and in the overall picture show that ITC has developed a vast amount of knowledge concerning the development and use of multi-usable courseware. This section brings this knowledge together in order to draw conclusions and define further actions.

5.1 Re-defining Multi-usable Courseware

The e-learning project defines multi-usable courseware as: “courseware which is suitable for use in different teaching modalities, such as face-to-face education, distance education and joint courses”. The experiences with using distance education courseware in face-to-face education show that distance education courseware approaches the concept of multi-usable courseware to a certain extent. This courseware is developed for independent study by distance education students and is therefore useful for all students wanting to study a certain topic independently; irrespective of whether these students study in a distance, face-to-face or joint course. However, not all courses use the independent learning or self-directed learning approach. In these cases, the distance education courseware might be of less value.

The initial definition of multi-usable courseware by the e-learning project does not mention pedagogy, but teaching modalities. Pedagogy can either be the binding or the differentiating factor between these teaching modalities. Differences and similarities in pedagogy between teaching modalities influence to what extent courseware developed for one teaching modality is usable in another teaching modality. A multi-usable pedagogy should therefore be added to the initial definition of multi-usable courseware:

Multi-usable courseware is educational materials which can be used in multiple teaching modalities. They are supported by a pedagogy which is applicable in these teaching modalities as well. Multi-usable courseware = courseware + pedagogy.

5.2 Towards a Multi-usable Pedagogy

The pedagogy of face-to-face teaching and distance education can differ substantially. In distance education students have to work more independent and have to motivate themselves to study because there is no teacher available at their location of study. Face-to-face teaching at ITC often follows a traditional pattern with lectures and practical sessions. In the case of GIS, Geostatistics and Hyperspectral Remote Sensing this traditional setup is left and a more distance-like teaching approach is chosen with fewer lectures, more self-study and on-demand question and answer sessions. The cases show that the use of the courseware in these situations is different. Courseware that is used in a traditional face-to-face teaching setup functions as extra study material, not as a replacement. In this setting, the courseware is valued less positively by the students because they rely more on the available face-to-face activities and the book. In distance education and a more independent approach of face-to-face teaching students rely more on the courseware and value it more positively. The added value of multi-usable courseware is only reached if the pedagogy is changed accordingly.

Independent learning emerges from the cases described in Chapter 4 as being the answer to the question about pedagogy from Paragraph 5.1. However, these results are coloured by the

pedagogy which was chosen for the distance education courses. Most distance education courses at ITC are set up as a kind of individual study package. The learner studies these materials independently; there is little attention for cooperation and peer learning. There are other pedagogies available (Laurillard, 2002; AUTC, 2002) which can be used in both distance education and face-to-face education.

The implementation of the independent learning pedagogy in education at ITC in the cases described in Section 4, give insight to what extent this pedagogy is multi-usable:

Students have certain expectations regarding pedagogy used in face-to-face education at ITC. The GIS and RS case both come from the first phase of the MSc curriculum. In this phase, students expect a traditional teaching setup and have little experience with studying independently. The pedagogy used does not match with this expectation and this leads to problems at the beginning of the module. In the Geostatistics and HSRS cases, which are much later in the curriculum, students are satisfied with the more independent way of studying.

There is heterogeneousness among ITC students in their experience with and ability to study independently. The GIS case shows that students have to be introduced to this way of studying and teaching by telling and showing what is expected of them. It would help if more modules would be taught this way so students can build up experience with this style of teaching and learning throughout the curriculum in stead of switching all the time.

The courseware which has been developed for the distance education courses differs in level of concreteness from the materials that are used in face-to-face education. The lack of teacher presence is often addressed by offering step-by-step exercises and guides which can be followed easily without mistakes. This conflicts with the academic nature of the MSc programme in which students are trained to work and think on their own in stead of following a step-by-step guide. It is therefore questionable whether step-by-step organized courseware is well multi-usable in later stages of the MSc programme and a student-centred curriculum. Other means of dealing with the lack of teacher presence should be sought.

5.3 Development of Multi-usable Courseware

Through the e-learning project a substantial amount of time and money is allocated for the development of distance education courses and their courseware. Although all distance education courses are based on existing in-house modules, it is not possible to use these materials for the development of courseware without serious rethinking and rewriting. The allocation of extra time and money motivates staff members to renew their educational practice and to enhance the quality of their educational materials and teaching.

The development of distance education courses is not always conducted with the concept of “multi-usable courseware” in mind but staff members involved in the distance education courses soon see new possibilities for using the well-developed distance education courseware. The approach for developing multi-usable courseware in the e-learning project has therefore become an elaborate one. First, an existing face-to-face course is totally reworked into a distance education course. Second, the distance education course is taught online and improved. Third, the

distance education courseware is used in face-to-face education at ITC or other educational situations. In this last stage, the multi-usability of the courseware is actually tested in practice. Although the process is elaborate, at this moment it seems to be necessary to come to multi-usable courseware because both the courseware and pedagogy coming from face-to-face education have to undergo a huge transformation before they can be used in other teaching settings such as distance education. More efficient development methods have to be sought.

REFERENCES

- Augustijn-Beckers, E., Kooistra, J. & Vekerdy, Z. (2008). Cross-fertilization between three teaching modes for geo-information education. Proceedings of the FIG International workshop on E-learning in Surveying, Geoinformation Sciences and Land Administration, Enschede, The Netherlands, 11-13 June 2008.
- AUTC, 2002. Learning designs. Products of the AUTC project on ITC-based learning designs.
<http://www.learningdesigns.uow.edu.au/> (accessed 11 May 2009)
- Boerboom, L. & Groenendijk, L., 2007. Can we benefit at ITC from distance learning? *ITC News*, 2007(1), pp. 8-9.
- Koper, R., 2003. Combining re-usable learning resources and services to pedagogical purposeful units of learning. In: A. Littlejohn (Ed.), *Reusing online resources: a sustainable approach to eLearning*, pp. 46-59. London; Kogan Page.
- Koper, R., 2006. Current research in learning design. *Educational Technology & Society*, 9(1), 13-22.
- Laurillard, D., 2002. *Rethinking university teaching: a conversational framework for the effective use of learning technologies*, 2nd edn. London: Routledge Falmer.
- Laurillard, D. & McAndrew, P., 2003. Reusable educational software: a basis for generic learning activities. In: A. Littlejohn (Ed.), *Reusing online resources. A sustainable approach to e-learning*, pp. 81-93. London: Kogan Page.

NEW E-LEARNING TOOLS AND THEIR USEFULNESS IN TEACHING PHOTOGRAMMETRY

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Commission VI, Working Group VI/1-2

KEY WORDS: E-learning, Virtual worlds, Pedagogy

ABSTRACT:

Especially various social medias, virtual worlds and mirror worlds, are presented as concepts. They are evaluated based on different viewpoints. For example, the usefulness of the media in teaching photogrammetry, easiness to start to use them either as teacher or student. The pedagogical aspects are also emphasized. During last decade Internet has become a basic tool in teaching. Universities have selected their own learning managements systems and usually the teacher has only limited possibility to select it purely based on his/her own preferences. When we are talking of new e-learning trends, the teacher's usually are on their own to start to use them. However, which trend is worth to follow, is usually harder to decide. The generation gap is also existing. For example, the skills to utilize various social medias might vary a lot. Examples from the use of these new tools are given. Both from the photogrammetry and remote sensing courses of Helsinki University of Technology and from other universities. It presents ideas how the various e-learning methods are utilized currently and ideas how to use new e-learning tools. The paper is hoped to be a starting point for the discussion.

1. INTRODUCTION

The Internet and computer has become a part of our daily life. The way we share our lives via Internet with other people has changed a lot in the way we work and study and spend our freetime. The decision to write a paper relating to the new e-learning tools turn out to be a challenging one. The more I have been studying the subject, the less ready I am feeling to express myself. The viewpoint to the subject is not an expert in virtual worlds, but a teacher who have to consider whether to spend her and student's time with them. However, I have tried to explain the concepts and to evaluate which new e-learning tools could be worth trying in teaching photogrammetry.

At first, some concepts are explained. Next the current e-learning infrastructure at Helsinki University of Technology (TKK) is introduced as an example from current learning and teaching environment. Then some examples from the teaching of photogrammetry relating to the use of the new medias are given. A small case of exploring Second Life is presented. Last there is a discussion about various aspects - the possibilities and threats, the generations of the users etc.

The intention of this paper is to open discussion and to encourage to innovative trials with the new e-learning tools.

2. CONCEPTS

2.1 Learning Management System (LMS)

Most universities have nowadays some kind of Learning Manamement System in use. There are both Open Source Software and commercial software available. Usually the university has selected the supported system and individual teacher has to use the selected one or arrange the support by herself/himself. The systems have usually the same basic functionalities, but the user interface can be different and they

might have been built based on the different kind of learning processes in mind. Example of Open Source Softwares are, for example, OLAT (<http://www.olat.org>) or FLE (Future Learning Environment) (<http://fle3.uiah.fi/>). FLE is server software for computer supported collaborative learning.

Compared to plain web pages and use of traditional email for communication, these environments usually provide management tools especially for the teacher. It is easy to share the course material. Communication tools are usually emails, various electronic noteboards and chats. With these kinds of environments it is easy to control the accessibility of the course material and to restrict the visibility of the discussion, exercises and such to the specific target group. However, without training we might have only limited functionality in use.

2.2 Social medias

Social medias are probably more familiar for us from unofficial use than from work related tasks.

How to define Social medias shortly? Wikipedia is not considered as a proper academic source, but in this case I think it is justified to refer to the Wikipedia's definition where social media is defined as "content created by people using highly accessible and scalable publishing technologies" and "it is transforming people from content readers into publishers". The form, technologies and applications vary. http://en.wikipedia.org/wiki/Social_media). Social networking, sharing of photos, video, music and and blogging have become part of computer use of numerous people. Even if you are not personally using these systems, you can read news relating to the Facebook, Twitter, YouTube, Blogs, etc.

If we consider our daily lives within last week, some of these technologies have already become part of our lives. And they are definitely part of our students lives. Of course, one person do not probably use all them and some of these applications are

still familiar only to small group of people. There is also a lot of discussion about the reliability, security question and such things. Use of social media might have even been restricted from some work places.

Various kind of communities have sprang up in the Internet. It can combine the people who share the same interest or experience. Such communities are created within people who might not have ever known each other without Internet.

2.3 Serious virtual worlds

Virtual worlds - especially Second Life - have gained a lot of media attention lately. There is an excellent report prepared for the JISC e-Learning Programm by Sara de Freitas (2008) called "Serious Virtual Worlds – A scoping study".

"A virtual or immersive world is an interactive environment often although not exclusively in 3D or animated graphics."

The report presents following categories of serious virtual worlds:

1. Role play worlds
2. Social worlds
3. Working worlds
4. Training worlds
5. Mirror worlds

Role play worlds or multiplayer role play online games (well-known examples are World of Warcraft, Everquest, Guild Wars) are usually used for leisure purposes. The line between social worlds is in practice blurred. Social worlds or open-ended exploratory immersive worlds are numerous in the area of supporting social networks and social interaction. Examples from such are Active Worlds Educational Universe and Second Life. Some of these worlds are targeted especially for children, such as Habbo Hotel.

Working worlds are corporate and business 3D spaces and intranets. Large corporations like IBM and Sun Microsystems have developed their own virtual worlds for corporates internal use (for example, Project Wonderland, IBM's Metaverse). Training worlds like 3D training simulations and serious games are used specifically for training of particular professions. Earlier these were focused on military training, but they are increasingly used in medical education. Last category is Mirror worlds using geo-spatial databases and mapping services. These are worlds or 3D visualizations that mirror physical world. Examples in this category are, for example, Google Earth, Microsoft Virtual Earth, NASA World Wind and Unype. Planet Earth is an open source version belonging to this category.

In her report, Sara de Freitas has listed over 100 different softwares/environments. It is a challenging task for an individual teacher to guess which once will be in use after a while and which of them have the best potential for educational use in her/his own area of interest.

Mirror worlds have a close connection to Photogrammetry and Remote Sensing while being presentations of the physical world. Later in this paper I will present example of the use of one mirror world in teaching (see 4.1 Google Earth)

In chapter 6 I will give a case study from the teacher's first experiences in Second Life. It is probably one of the most discussed social virtual world on the market currently.

The corporate internal virtual worlds will probably be our future working environments and therefore it is useful to gain experiences of studying within virtual world. Our future students will probably be experienced users of various leisure and social virtual worlds. As much as I'm aware of teens world, many of them have been users of Habbo Hotel or similar worlds or spent time in the role play worlds. Of course, it has to be kept in mind that there is no homogenous generation in this sense.

3. TKK – OFFICIALLY SUPPORTED SYSTEMS IN TEACHING

Helsinki University of Technology (TKK) has just finished so called eTKK-project. One of the subprojects was the creation of Noppa –portal. This portal unifies the information flows relating to the studying. Beside Noppa –portal there are two other teaching related computer systems in use. Oodi is the administrative program for data relating to the studies. Third system is Optima – which is elearning System selected by TKK. The teachers can share their course material through Noppa-pages or use Optima. However, in Noppa you have to define where the course material is available. In addition to these three systems the university offers a wiki.tkk.fi tool for our use. The goal has been to make a clear structure to the study related systems.

Our research group (Institute of Photogrammetry and Remote Sensing) is responsible for the teaching of Photogrammetry and Remote Sensing. We have had our own Internet server since 1995. Since that we have had our own course web pages for the students. Now we have adopted the new obligatory systems. WebOodi has replaced the earlier course administration system, Noppa-portal is the official course page portal and Optima is the official e-learning system offered by our university.

3.1 Weboodi

This is administrative course information system. System contains the curricula information and the students use it to sign for the courses and exams etc. Weboodi's databases are then used by the Noppa –portal.

3.2 Noppa –portal

Our newest system in teaching is the study and teaching portal Noppa (<https://noppa.tkk.fi/>) which works together with Weboodi system. Their roles are defined as follows: "from Noppa you can find things related to daily studies, whereas WebOodi is meant for more "official purposes, such as enrolment on courses". Noppa contains course web pages, personal start page with the latest news and upcoming events of the courses student is attending. The student can define his/her settings how the information is delivered. It is, for example, possible to order course news as RSS feed. The main advantage of Noppa is that it has unified the course pages at the University level and it has received the status of an official notice board in teaching related subjects.

3.3 Optima

Optima is the Learning Management System selected (and also supported) by our University. The users need to have an account granted by the University computer centre. The workspaces are normally created for the specific course. It has often replaced the delivery of course material in open web pages as we did earlier. It could and should be discussed, if the universities

should have their lecture material available for public. However, for keeping the returned exercises etc. in order or work as groups makes this kind of system excellent compared to the situation when the reports were returned by email and every tutor had their own system to organize them. It is also great to have a system accessible from everywhere (the reports are not at work computer when you want to see them from home) and it is easy to create an archive file after the season or copy the content for the next year. Maybe the Optima is not the easiest or best of the available LMSs but it is currently the one supported by the University.

Teachers who have attended the pedagogical training organized by the University teaching unit also have gained experience from the use of the system. It makes it easier to start using it with your own students.

3.4 TKK wiki service

In addition to these three study related systems we have a co-operation and publish tool also known as wiki.tkk.fi. It is available for everybody at Helsinki University of Technology, Helsinki School of Economics and University of Art and Design Helsinki (incoming Aalto University will be composed from these three universities). TKK wiki contains personal wiki spaces and collaboration wikis.

3.5 Other systems in use

Unofficially there are nowadays many systems in use beside these official systems. Newsgroups are still in use in some areas of interest. Various email lists can still be effective way to distribute or gain information. For example, student guild have its own list and it is often a great information source even for the teacher. New tools are becoming popular. For example, Doodle (www.doodle.com) seems to be a great tool to make appointments.

4. EXAMPLES OF TEACHING WITH NEW E-LEARNING TOOLS AT TKK

In this part of the paper I will give few examples of the ways we have used new tools in our teaching at Helsinki University of Technology.

4.1 Google Earth, example of Mirror world

From Virtual worlds most promising category for our teaching so far has been the mirror worlds.

We have used Google Earth in the Introduction to Photography, Photogrammetry and Remote Sensing course in study years 2006-2008. The course is intended for first year students of Surveying (both Geomatics and Real estate economics programmes).

In this exercise students use Google Earth (<http://earth.google.com/>) and Citizen's MapSite by Finnish National Land Survey where they had access to NLS topographic maps covering all Finnish regions. (<https://www.karttapaiikka.fi/karttapaiikka/default.asp?id=787>).

The aim of the exercise is that the students use Google Earth to familiarize themselves with various aerial and satellite imagery. They learn how the Earth looks when looked above. They also study how different objects can be distinguished from different images. They compare the Finnish topographic maps and aerial or satellite images in Finland. Finally they return a small report and also suggest their own candidate for the amazing or

interesting spot found from GoogleEarth. Example of these places can be found from the following page http://foto.hut.fi/~milka/opetus/harjoitukset/maa1010/2008/Google_Earth_kilpailu2008.htm.

We have plans to use Google Earth in another way in some other course. The possibility to publish 3D models in there might be a good way to present results from various modelling exercises. We believe that it would also be motivating for the students to do a modelling which result will be visible to bigger audience.

4.2 Geocaching

Geocaching has become popular hobby around the world. The official global GPS cache hunt site <http://www.geocaching.com> defines it as "a high-tech treasure hunting game played throughout the world by adventure seekers equipped with GPS devices". To our research group belongs an active geocacher and she has created two caches on behalf of our research group. These caches are so called mystery or puzzle caches.

The two caches so far are

Foto1: [Stereonäkö](#) by fotogrammetria (GC1AV6Q) Finland

Foto2: [Ilmakuvaus](#) by fotogrammetria (GC1R69W) Finland

The first one is relating to stereovision. The coordinates are hidden into a stereoisimage. Another is relating to aerial photogrammetry and contains a basic calculation exercise. The cache information is in Finnish and in English. This is a interesting way to get people aware of our profession and special area of interest. The geocaching is a popular hobby and within enthusiasts there are potential future students who might get their inspiration from this kind of exercise. Also our students seem to be happy to find such caches. Although not part of any official curricula this kind of caches can be nice promotion of our research group.

4.3 Innovation exercise and blog

Last spring we had first time so called innovation exercise. In this exercise the second year students were divided into groups of four. They visited a company where they gained information. The task was to create an innovation within the course. The group has a tutor from our research group available. The exercise had a structure and the groups wrote a wiki or blog from their process into Optima (LMS used in TKK). The final results were presented after six weeks. Some of the groups made really interesting innovations and generally every group made a good process.

5. EXAMPLES OF TEACHING WITH NEW E-LEARNING TOOLS IN OTHER UNIVERSITIES

The YouTube was a positive surprise for me. I have been watching the YouTube videos seldom - usually after some hints from the colleagues and usually fun ones. In Finland we have also sad examples of videos published in YouTube relating to school shootings. This has probably affect on my prejudice on YouTube. However, I have been aware that it is popular media and it is used to reach for promoting the profession for the possible future students- There are few nice videos relating to this. For example, "make your mum happy - study geomatics!"

http://www.youtube.com/watch?v=_h8ZWh3Qscc

However, when doing search with the keyword photogrammetry I found several nice examples, which have great potential in teaching of Photogrammetry or Remote Sensing. Because the content of YouTube is probably changing rapidly I will only mention few examples of interesting types. There are several videos created by the companies on this industry. Also the videos published by ASPRS relating to their 75th anniversary where very well done and I can see a lot of potential to integrate them to teaching. As an example, there are titles like “evolution of analog to digital mapping (<http://www.youtube.com/watch?v=SB1u6-DDwpU>), “the role of women in the history of photogrammetry” (<http://www.youtube.com/watch?v=KuJ32mUjYk4>) or “photogrammetry in space exploration” (<http://www.youtube.com/watch?v=4JDERWH38Y0>)

What made me really to understand the possibilities of the YouTube was when I found National Programme on Technology Enhanced Learning (programmes website <http://nptel.iitm.ac.in/>). The programme’s video lectures can be accessed in <http://www.youtube.com/iit> It is a good example how the material is organised as playlists and it is easy to see who has created the material and for what purpose. Example of an individual course is “The Civil – Surveying lectures by professor Bharat Lohani, Department of Civil Engineering, IIT Kanpur.”

It has to be remembered that YouTube is a delivery channel. Usually it might not be so easy to find out who is behind the individual video or what purpose it is originally done. Therefore we have to remember that we are mostly teaching at the universities. For the professionals who have already some career it might be easier to judge the relevance of the material. You can probably evaluate what has been told and what has not been told in commercial material. You might even know the lecturer. The criticism of sources is something where our students should have help from the teachers and therefore it would be valuable to use this kind of material as a part of other teaching methods. The evaluation of the relevance and correctness of the material is needed. Of course, also the questions of the copyright and correct referencing have to be solved.

6. EXPERIENCES FROM SECOND LIFE

Second Life by Linden Lab (see <http://www.secondlife.com>) is probably one of the most used virtual worlds in educational use. Several Finnish educational institutes have region in Second Life called EduFinland. So far, Helsinki University of Technology does not have their own official place there.

From social worlds probably Second Life has had the most media attention relating to the teaching – at least in Finland. However, when discussing with my colleagues at Surveying Department it seems that those working with Facility management are most aware about it because it relates to their research with virtual working spaces.

I started my personal experience gathering project with Second Life in February-March 2009. I did it beside other teaching projects and did not use any official technical or other support for it. The installation of Second Life was easy. In my work computer even the graphic card was good enough to support the program. However, the regional handshake problem took over two months. Finally, one day in May it suddenly was over. My

wild guess is that the European Parliament election campaign solved the problem. One former researcher of our university was having his campaign event in Second Life. After that the system started to work. At home computer the program complained about the graphic card, but functions with reduced graphic quality. At home, I never have had the regional handshake problem which is probably related to firewall settings

When I was trying to solve the handshake problem I read a lot of guides written for Finnish polytechnic schools, but they seem to concentrate on the outlook of avatars. In Finland, so called Uni-Finland island(s) are bought from the Linden Lab. The area is further rented for Finnish educational bodies So far it is still quite much a play ground for the pedagogical units.

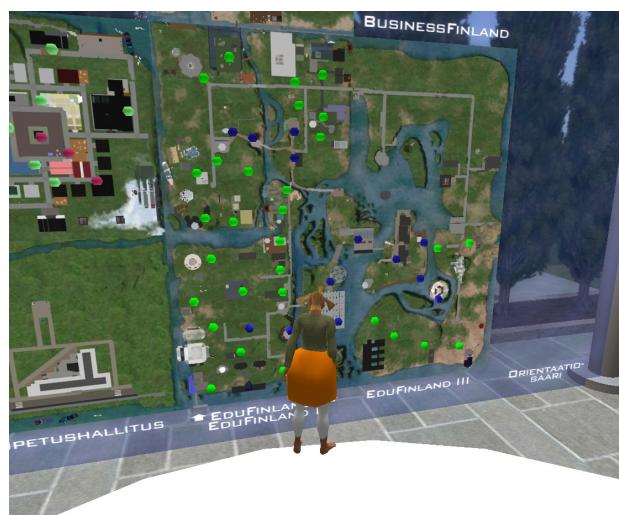


Figure 1. Author’s avatar studying map of EduFinland in Second Life

If you do not have a specific event arranged in Second Life the hanging around does not feel very improving. I would say that it would be easier to find information in traditional internet or library. However, I can imagine that if you have a headphone and microphone installed you can have really interesting discussions and events in Second Life. But I also noticed a surprising side that I felt myself very shy when going around in Second Life. That was probably due to the fact the rules of the environment were unclear for me. How to start conversation, what are the general habits, how to behave and so on, Personally I’m not experienced chat user. However, my short visit in the coffee table by Helsinki University teaching support unit was a nice experience of the possibilities in Second Life.

It would be interesting to make a real teaching experiment in Second Life. But before it, I would like to have some kind of training relating to the environment and I would like to have a support unit who could answer to the basic questions of the students relating to technical questions. I think that for delivery of the material the traditional LSM systems and Internet is much more faster and reasonable, but I look forward to see what it would be to have a real meeting or social event in Second Life. When the money to travel around is harder to get, it might offer a solution to meet colleagues and have interesting discussions.

7. STUDENTS AND TEACHERS

A good question relating to these new e-learning tools is who is the teacher and who is the student. What kind of learning experiences we want to achieve and who has the role to arrange those learning experiences. Do we have a similar control over the learning process as we have believed to have in traditional class environment. Do we need to learn new kind of teaching skills to teach in virtual worlds? Do we still need teachers?

“Generations” in the use of various environments are not necessary related to age or length of the working career. What is the personal experience of using computer games, environments, internet, social media etc. People might have strong skills within some kinds of environments, but be novice in another type of environment.

A good virtual community has some unwritten laws how to behave online. Compared to open anonymous discussion groups the closed communities with people having a certain identity are usually well-behaving. Sometimes there are discussions what is ok and what is not.

Teachers are not necessary more experienced than their students with the new environments. This is a challenge for the planning of learning process. What do we want to teach and to learn? How we can define the learning task and how we know what is the learning result? How we define the work load and objectives. How this all is converted to a certain degree?

One of the problems with all these new e-learning tools and possibilities is how to share your time. The real world restrictions are still existing - you still have only 24 hours in a day. Even if the virtual worlds are immersive, people do need to spend there time in real life, too. Therefore it is good to define a clear learning process and to use appropriate tools for it.

E-learning was earlier thought almost as an synonym for distance learning. Nowadays e-learning tools are not just a way to enable distance learning or self-learning. We have to realize that e-learning tools enable new ways to work together despite the distance. The global organizations have to start really working online. Due to climate-change and also for economical reasons it is better to work in virtual communities than to travel around. I do not believe it will replace the real meetings, but it will make it possible to work together more actively within meetings in real life. Traditional video conference tools etc. have been quite expensive to use. People have learn to use inexpensive tools like Skype, web-cams etc. in their private life. It is clear that such tools can be useful also in education.

In new student generations there are persons familiar with systems like World of Warcraft, Habbo Hotel, Sims3 etc. I have always had enough to do without trying these. However, I have started to use Facebook – even if I have my own personal rules how to use it. I’m not sending so many private emails than before. There are Twitter. How many of us is using blogs. There are anonymous blog vs. personalized blogs. Good blogs are interesting to follow. Writing a private blog might be an excellent way to study. We have to remember that it is possible to restrict who is allowed to see our text.

Equipment. Some environments like Second life needs specific graphic cards etc. It can be said that they are not accessible for everybody. To get full experience from the environment, you should also be able to use microphones, headphones etc. For

example, I have so far only used keyboard for communication in Internet.

It is easy to get lost. If you try to learn the environment just by learning without reading manuals, through trial and error, it will take time. At the moment there is no official support for using virtual environments. It is up to teacher’s own interest to start using these. However, it can be really interesting. It is still good to remember basics. Do we want our students and teacher to learn photogrammetry or to learn how to use and install the environment.

8. DISCUSSION

Like in the beginning of the use of Learning Management Systems – there are various brands and probably few standardized tools within new -e-learning tools. There are open-source systems which demand more skills to install. There are browser-based systems and stand alone systems. The requirements for the computer equipment are varying. How much computer skills are needed to start using the systems. In many universities there are centralized computer support units and you have to follow the general systems selected or you have to put the system up by yourself. How much time and effort an individual teacher has for keeping up-to-date with all new systems outside the own research area.

These new e-learning tools offer great possibilities for co-operation and new innovative ideas in teaching of photogrammetry. To get them into real use we need experiences from these new environments. These can be gained, for example, while using them together with teacher colleagues for sharing experiences from teaching.

REFERENCES

- De Freitas, S.. 2008. Serious Virtual Worlds a scoping study. Prepared for the JISC e-learning Programme. Document N°480 Version 1.1. November 2008. <http://www.jisc.ac.uk/publications/documents/seriousvirtualworldsreport.aspx> (accessed 27th May 2009)

E-LEARNING IN HIGHER EDUCATION INSTITUTIONS: ACCEPTANCE AMONGST STUDENTS AND STAFF

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KEY WORDS: e-learning, surveying, education, training,

ABSTRACT:

This paper presents an investigation into the approval of e-learning tools and applications in higher education institutions. The developments of e-learning tools are still very time-consuming and require commitment and enthusiasm of university staff. This study investigates if e-learning tools are worth the investment and if students as well as academic staff accept these as new innovative learning tools. The investigation is based around two e-learning tools which were developed at Newcastle University to support the learning experience of students in the area of Geomatics.

A virtual traverse and a levelling e-learning tool were developed to provide students with an opportunity to improve, enhance and test their learning experience and knowledge in a Geomatics context. It was hoped that the tools would provide a replacement for the cancelation and cut-backs of fieldcourses and practicals due to escalating cost (both financial and staff time) in recent years. Both tools were created as interactive tools, which require the students to perform measurements, calculations and answer questions, thereby offering a learning tool as close to a real practical exercise as possible. Immediate feedback is provided to the students for measurements and calculations to confirm or offer the students a chance to improve and assess their learning.

Both tools were made available to different cohorts of undergraduate students at Newcastle University via the University's website. Students were encouraged to use the e-learning tools in preparation to practicals and the fieldcourse, as well as for exam revision. No formal assessment was linked to the use of the e-learning tool, therefore students were using the tool on a volunteering basis.

This paper will present the results and analysis of the student's feedback to using e-learning tools, assessing thereby if e-learning tools find acceptance among students but also university teaching staff. Students and university staff members were questioned regarding their opinion of e-learning as teaching tools. The opinion of academic staff was rather conservative regarding the replacement of traditional teaching methods, such as practicals and seminars, with e-learning. Students on the other side were a lot more open to e-learning tools and certainly saw potential in them as learning tools. However, the questionnaires as well as monitoring of the use of the tools showed that students require an incentive to use the tools, i.e. an assessment. This paper will show that the development of e-learning tools may seem exiting and innovative, but the student's acceptance of these tools has to be considered in their development, so resources and time can be allocated appropriately.

1. INTRODUCTION

E-learning tools, techniques and applications have gained a lot of attention in various levels of education over the last years. It resulted in the development of a several e-learning tools, partially involving large amount of public money investment, e.g. Gitta (Gita, 2009). A large amount and variety of e-learning tools therefore now exist and can often be accessed free-of charge over the internet. An overview of e-learning tools and software in the area of remote sensing and photogrammetry can be found on the website of the ISPRS working group VI/2 ((ISPRS_WG_VI/2, 2009)). The range of tools, software and applications shows the interest of teaching staff in e-learning tools and that a high potential is seen in such tools. Some of the tools have clearly been developed with the student in mind, but it is not always logistically possible to involve students in the development process. This study therefore aimed to assess the student opinion of e-learning tools. It investigated if e-learning tools are worth the investment and if students accept these as new innovative learning tools. The investigation is based around two e-learning tools which were developed at Newcastle University to support the learning experience of students in the area of Geomatics.

1.1 Geomatics at Newcastle

Geomatics at Newcastle University offers two Geomatics related undergraduate degree programmes, Geographic Information Science and Surveying and Mapping Science. Additionally, surveying is also taught as a Stage 1 and Stage 2 modules in the Physical Geography (20 students) and Civil Engineering (c. 85 students) undergraduate degree programmes at Newcastle University, consisting of numerous practical sessions, in addition to lectures. Traditionally, residential fieldcourses contributed to the learning process of the students, as these are seen as an effective learning experience for students to gain competent knowledge in any subject related to surveying. However, the escalating cost (both financial and staff time) of running residential fieldcourses have led to cancellations and cut-backs in the subjects of Geomatics at Newcastle University, UK. Alternative teaching methods therefore have to be found to improve the learning experience to compensate for the missing fieldwork experience. It was expected that e-learning tools could offer a possible solution to overcome the missing practical experience.

2. THE USE OF E-LEARNING TOOLS AS VIRTUAL FIELD COURSES

Fieldwork and fieldcourses are an important learning tool for any Geoscience degree. Residential fieldcourses have been carried out in many studies successfully for many years and have found a wide appreciation for learning amongst students. However, as residential fieldcourse are very financial and staff resource intensive, alternatives for fieldcourse are often sought by universities. E-learning tools may provide such alternative.

Virtual fieldcourse, as examples for e-learning tools, have been developed with the aim to enhance the learning experience of students in the context of existing residential fieldcourses. Any virtual fieldcourse development can be understood as an inspiration to improve the overall student learning experience (Phipps, 2001). There is no definition for virtual fieldcourses (VFC) yet available, but the UK Higher Education academy defines a virtual field trip as a “type of simulated field trip undertaken through the Internet” and a virtual laboratory as a “technological instrument that allows the simulation of laboratory or other equipment on a computer” (HEAcademy, 2007).

VFCs have now been developed at several institutions across the world. Existing VFCs in the UK range from live web-cameras to full interactive virtual fieldtrips (GDN, 2001). An example for an existing VFC is the development of a Dark Peak virtual tour as a introduction and preparation tool for a geography fieldcourse (McMorrow, 2005). It took up to three years to develop the complete virtual tour, highlighting the cost and time associated with its construction. A student survey for this virtual tour highlighted that students got mixed enjoyment out of using such learning tool and did not necessarily see it as an improved learning tool to help their understanding of the subject (McMorrow, 2005).

On the other hand, the costs of the development of any e-learning tool are often underestimated, as any new development in the virtual world involves costly starting costs (Issroff and Eisenstadt, 1997). Additionally to the cost and time consuming production, as well as specialist computing and web-management skills which may have to be obtained, requiring additionally training for staff members (Curry and Burton, 2006). This shows, that the development of a VFC does not automatically promise a new successful teaching resources or a revolution of teaching.

3. THE VIRTUAL INTERACTIVE TRAVERSE LEARNING TOOL (VITLT)

The analysis of the acceptance of e-learning tools amongst students was carried out on the basis of two e-learning tools which were developed at Newcastle University. Both tools aim to aid the learning experience of students in Geomatics related subjects. To achieve an acceptance of the tools by students, students of different stage in the degree programme were asked to provide feedback during the development and their suggestions and comments were integrated in the final VITLT. Additionally, the following recommendations, gained of previous studies, were consequently considered during the development phase of both e-learning tools (McMorrow, 2005):

- Use of linear structure including a link on each page back to the main map
- Use of annotated graphics

- Offer self-assessment at the end of the on-line exercise.

3.1 Development of the virtual interactive traverse learning tool

A virtual interactive traverse learning tool (VITLT) was developed in 2007 to improve the understanding and learning of surveying methods, in particular of traversing. The development of the e-learning tool was funded for 1 ½ months by Newcastle University. The tool aimed to simulate the observation and calculation of a surveying traverse. The VITLT is based on several traverses around Newcastle University campus. Maps and photographs are presented together with an explanation and description in a surveying context to familiarise students with the setting of a realistic traverse observation environment.

Virtual observations at each traverse station were realised via hotspots on an overview map and 360 degree panoramic images. This allowed the students to gain a similar spatial orientation to that which they would have when observing a real traverse. The student can pan and zoom the image to locate the target and click to take a measurement, the horizontal, vertical angle and slope distance are displayed in a virtual total station display. The virtual interactive traverse tool was prepared using Asynchronous JavaScript Technology (AJAX), allowing a dynamic website to be created.

3.2 The Virtual Interactive Traverse Learning tool

The VITLT design consists of the two main elements: the admin pages allowing new traverse to be entered and only to be accessed by the administrators and of course the student exercise pages, which presents the public face of it.

The admin webpage of the VITLT summarises the existing traverses within the system to the tool administrator (Figure 1). Additionally, the webpage allows to set-up new traverses together with data, pictures and design.

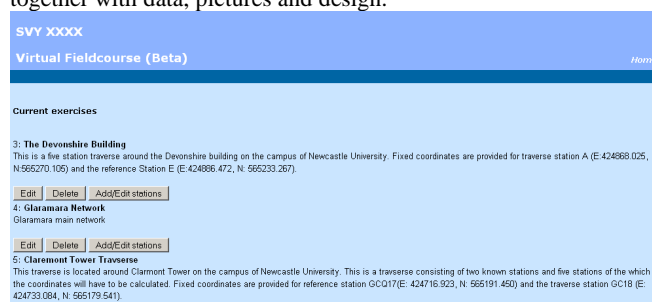


Figure 1: Admin page of the VITLT

Any new traverse to be added to the VITLT database is required to have been calculated and the complete solution entered into the project database.

The first student page of the VITLT (<http://www.ceg.ncl.ac.uk/pls/vfcourse/index.aspx>) informs the students of the outline, objectives and assessment of the VITLT (Figure 2). Once the students familiarised themselves with the objects and aims of the exercise, a traverse can be selected.

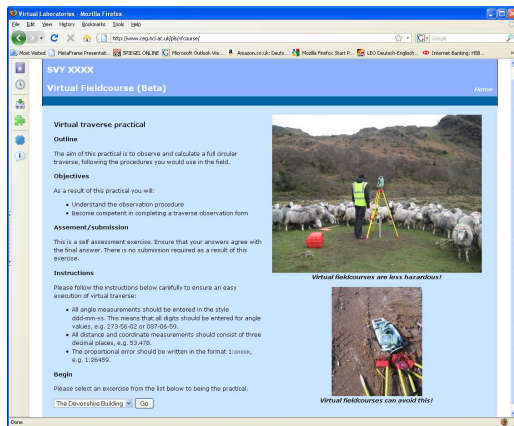


Figure 2: The student introduction page to the VITLT

Once the traverse is chosen, the students are presented with a Google Map overview of the traverse stations. The student must decide which station should be observed first and has to choose the station. This loads the QuickTime movie presenting a 360° picture panorama. It allows the students to scroll and zoom around in the picture (Figure 3). Once the other station is identified, a measurement can be carried out by clicking on the image. This measurement consists of the horizontal and vertical angle together with the slope distance (Figure 3).

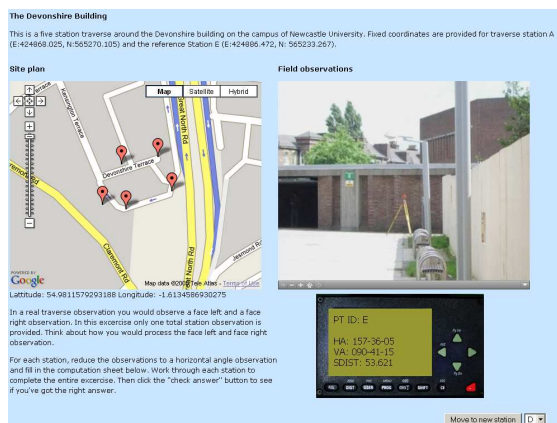


Figure 3: Set-up for traverse observation from one station

Once all measurements are observed, the students are required to calculate the traverse data by hand and fill in the traverse calculation sheet. The traverse calculation sheet is based on the Newcastle University template for the calculation of a 2D traverse and should therefore be familiar to the students. All data inserted by the students is assessed in real time and an indication for a correct or incorrect value is given. The VITLT allows students, to self-assess their traversing observation and calculation skills, instead of the currently used summative assessment.

4. THE LEVELLING E-LEARNING TOOL

The developed levelling e-learning tool was developed at Newcastle University with the substantial input of a final year student. It is therefore based on student input and opinion and developed directly under the student's influence. The levelling tool was created to provide students with a revision tool for levelling, allowing them to gain some background information but also testing their knowledge with several quiz questions, as

well as testing their levelling skills with an e-learning levelling exercise. The tool was generated with the software Adobe Captivate. This software allows to capture movements on screen, e.g. software but also the creation of quizzes as part of its Learning Management System. The final output is a set of interactive HTML webpages.

The student is presented with an overview on the start page (http://www.ceg.ncl.ac.uk/pls/virtual_levelling_tutorial/home.html), which allows the student to work through the e-learning tool chronologically or jump to a particular section of the levelling e-learning tool (Figure 4).

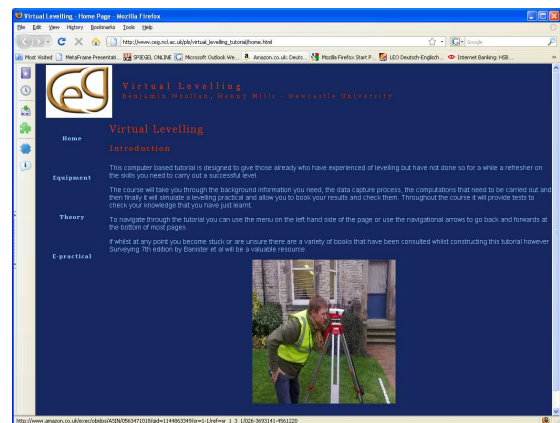


Figure 4: Start page the leveling e-learning tool

Animations and graphics are used interactively show different aspects of levelling and involving the student in the e-exercise. It aims to help students to use the e-learning tool but also to engage in the tool and thereby the learning process. Animations and interactive quizzes are used for every aspect of levelling, providing the students a comprehensive e-learning tool (Figure 5).

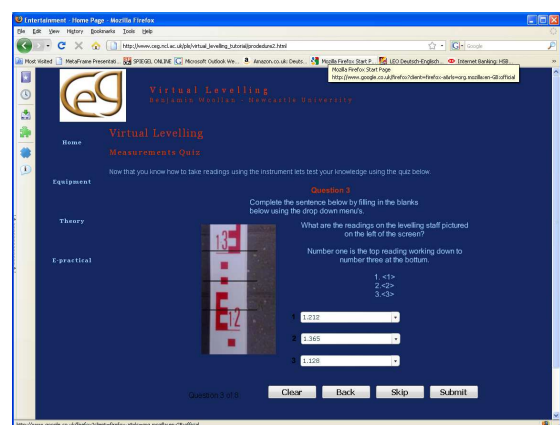


Figure 5: Quiz question example

The e-learning exercise is concluded with an e-practical consisting of a complete levelling routine/loop (Figure 6). The student is required to read the staff, presented on a picture and complete the levelling booking form including all calculations. Immediate feedback is provided to the students, as soon as one value is entered.

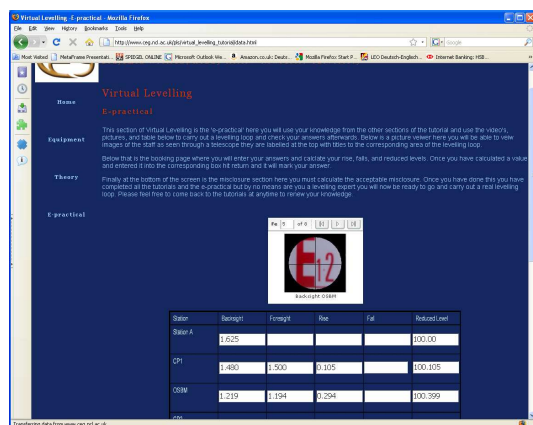


Figure 6: E-levelling practical

The levelling tool benefits to the learning and revision of students, as it can be repeated at anytime and provides a real life example to the subject area.

5. EVALUATION OF E-LEARNING AMONGST STUDENTS AND STAFF

It was hoped that both e-learning tools would provide a replacement for the cancellation and cut-backs of fieldcourses and practicals due to escalating cost (both financial and staff time) in recent years. Both tools were created as interactive tools, which require the students to perform measurements, calculations and answer questions, thereby offering a learning tool as close to a real practical exercise as possible.

Both tools were made available to different cohorts of undergraduate students at Newcastle University via the University's website. Students were encouraged to use the e-learning tools in preparation to practicals and the fieldcourse, as well as for exam revision. The tools were briefly mentioned during lecture and links to the website were provided from Blackboard. No formal assessment was linked to the use of the e-learning tool, therefore students were using the tool on a volunteering basis.

To assess the use of the e-learning tools and the student's opinion of them, questionnaires were given to the students. The questionnaires ranged from questions if the students enjoyed the use of the e-learning tool and if they would like to use more e-learning to questions which asked the students under which circumstances e-learning tools would be used or seen as helpful. The following section presents the results of the questionnaire of Stage 1 and Stage 2 Geomatics students at Newcastle University.

Generally, it was disappointing to see how few students used the e-learning tools on this optional basis. In stage 1 only 5 out of 51 students (less than 10%) and in stage 2 only 8 out of 30 students (27%) used the tool for revision.

5.1 Feedback on the use of e-learning tools

Due to small sample of students who used to e-learning tool the feedback was combined from Stage 1 and Stage 2 students.

Generally, the students found the e-learning tool easy to use and easy to follow (Figure 7). This is encouraging for the developers, that the tools were generated in an appealing style and with sufficient instruction for students. From a design

perspective, the use and acceptance of the e-learning tools should therefore not be a limited.

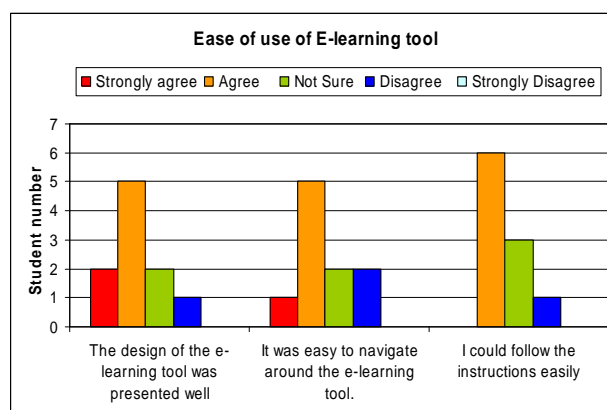


Figure 7: Response to use of e-learning tools

A larger variation in answers was found if the students were questioned regarding the outcomes and benefits of the e-learning tools. There was generally agreement amongst the students that the e-learning can be helpful to support the learning and understanding (Figure 8). As such the students saw the potential for the preparation of practicals. However, the student opinion overall showed that such e-learning tools could not be used as a replacement for practicals.

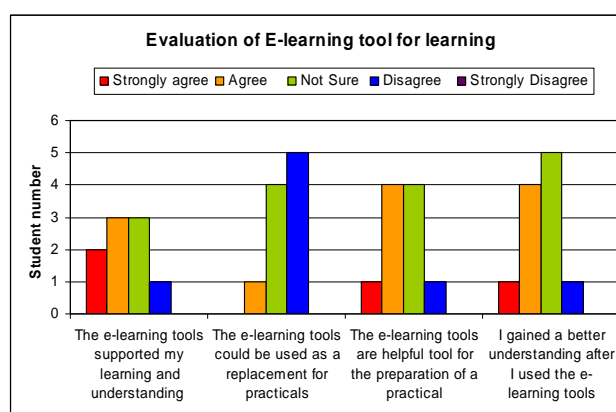


Figure 8: E-learning tools for learning

The last section asked the students to compare the e-learning's tools to more conventional teaching methods, such as face to face. Unfortunately, the student opinion on this comparison varied a lot, providing no clear answer for the student preferences (Figure 9). On one site, it showed that there is no overall strong agreement amongst students to use e-learning tools instead of conventional learning methods. At the same time there was no clear disapproval of e-learning tools following the questionnaire results.

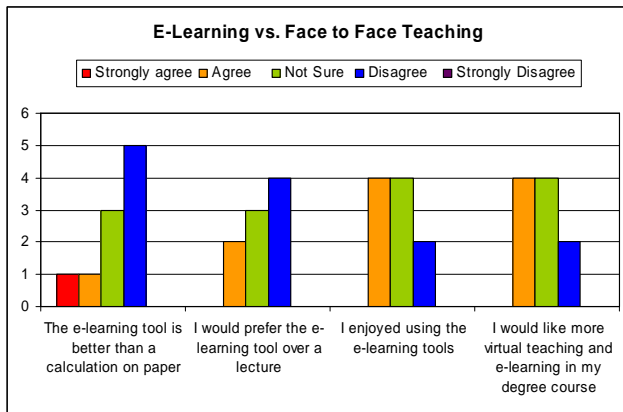


Figure 9: E-learning vs. traditional teaching methods

The questionnaire results of the students who used the e-learning tools showed no clear approval or disapproval of e-learning tools, highlighting that students see them as possible complimentary tools but not as replacements for existing teaching methods.

5.2 Feedback on possible use e-learning tools

As mentioned above the majority of the students did not use the e-learning tools on an optional basis for e.g. the preparation of the fieldcourse. If e-learning tools are being developed, it has to be taken into consideration under which circumstances students would use of such tools.

The first set of questions aimed to analyse why the students did not use the e-learning tools (Figure 10). It showed that it was not the e-learning tools themselves, which prevented the students from using it but rather a missing incentive. Additionally, the students declared that a practical exercise such as covered with these specific e-learning tools would be preferred. Of course without actually carrying out the e-exercise, the students may have not realised that the e-learning tools were designed on the basis of real world examples (Figure 10).

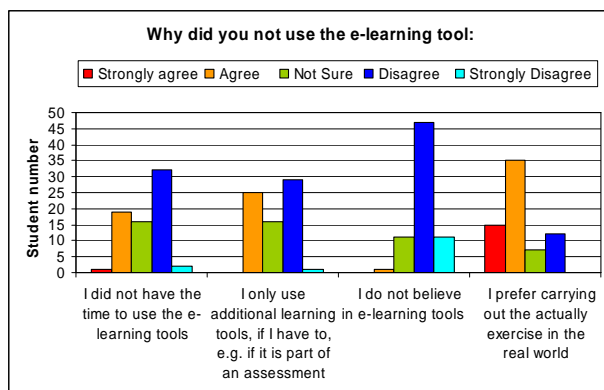


Figure 10: Reasons for avoidance of e-learning tools

Apart from investigating why the students did not use the e-learning tools, it seemed important to analyse under which circumstances e-learning tools would be used for learning by students. It showed very clearly that students require an incentive or motivation to use e-learning tools. Students will not use e-learning tools to support their learning if the tools are available (Figure 11 and Figure 12). If however, an assessment is tied to the e-learning tool or it presents the only option to

obtain new teaching materials, students would carry out the e-learning exercised to obtain the skills.

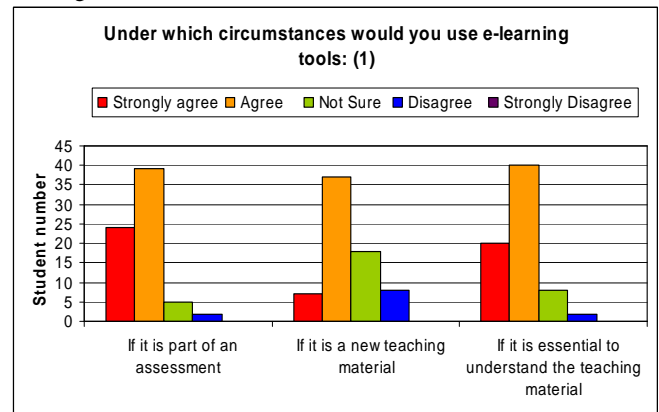


Figure 11: Conditions for using e-learning tools (1)

These statements were confirmed with a further analysis which showed that e-learning tools would gain a much higher acceptance amongst students if they were part of a practical or essential for the preparation and therefore execution of a practical exercise (Figure 12). A large discrepancy showed when students were asked if they would prefer e-learning tools over practicals. This preference depended on the individual and therefore personal strengths and opinions.

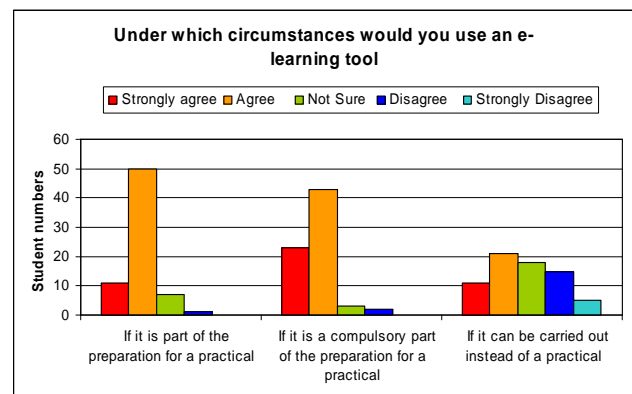


Figure 12: Conditions for using e-learning tools (2)

6. CONCLUSION AND SUMMARY

The study investigated the acceptance amongst students for e-learning tools using a variety of questionnaires. The analysis was carried out on the basis of two e-learning tools which were developed at Newcastle University to aid the understanding and learning for students of basic surveying skills and knowledge. The students who used to e-learning tools enjoyed their use and felt engaged by them. Students were open to e-learning tools and certainly saw potential in them as learning tools. However, the e-learning tools were not seen as a replacement option for actual practicals. This view was confirmed by the large amount of students who did not carry out the optional e-learning exercises in preparation of practicals. The analysis showed very clearly that students require an incentive to use the tools, i.e. an assessment.

These finding confirmed views that e-learning tools show a high potential as new and innovate learning experience for students (Spicer and Stratford, 2001). But such tools cannot replace traditional well-established teaching methods or

substitute any. Despite the students familiarity with e-tools, in their day to day life (e.g. facebook, MySpace) e-learning tools have to be designed with the student in mind, as student do not automatically take to these over traditional teaching methods. Resources used for the development of e-learning tools should therefore be used accordingly and appropriately.

7. REFERENCES

- Curry, G.B. and Burton, C.J., 2006. Use of Virtual Fieldtrips in Earth Science. In: <http://goodpractice.gees.ac.uk/cgi-bin/searchspec.pl?terms=218> (Editor), accessed 24 April 2007.
- GDN, T.G.D.N., 2001. Providing Learning Support for Students with Mobility Impairments Undertaking Fieldwork and Related Activities. In: <http://www2.glos.ac.uk/GDN/disabil/mobility/toc.htm> (Editor), accessed 24 April 2007.
- Gita, 2009. Geospatial Information & Technology Association. <http://www.gita.org/>. <http://www.gita.org/>. (accessed 19 May 2009).
- HEAcademy, 2007. Uk Higher Education Academy. <http://www.heacademy.ac.uk/2288.htm>. <http://www.heacademy.ac.uk/2288.htm>. (accessed 4 June 2007).
- ISPRS_WG_VI/2, 2009. ISPRS Working Group VI/2 : E-Delivery of Education Services. <http://www.commission6.isprs.org/wg2/>. <http://www.commission6.isprs.org/wg2/>. (accessed 16 April 2009).
- Issroff, K. and Eisenstadt, M., 1997. Evaluating a Virtual Summer School. *Journal of Computer Assisted Learning*, 13: 245-252.
- McMorrow, J., 2005. Using a Web-based Resource to Prepare Students for Fieldwork: Evaluating the Dark Peak Virtual Tour. *Journal of Geography in Higher Education*, 29(2): 223-240.
- Phipps, L., 2001. Reflections on Virtual Fieldwork. Another Note On the iNternet: ANON.
- Spicer, J.I. and Stratford, J., 2001. Student Perceptions of a Virtual Field Trip to Replace a Real Field Trip. *Journal of Computer Assisted Learning*, 17: 345-354.

E-ASSESSMENTS AND E-EXAMS FOR GEOMATICS STUDIES

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KEY WORDS: eAssessment, eExams, ePractice, First-Year Problems

ABSTRACT:

We report about our project to introduce web-based automated assessments for engineering studies at the HafenCity University in Hamburg. The assessments are used for free practice and for eExams in the near future in the first-year math lectures of the geomatics studies in Hamburg. We use the out-of-the-box system MapleTA which enables us to put mathematical questions with randomized numbers as well as randomized symbolic parameters. The system uses an inbuilt computer algebra system to grade the answers automatically. Unlike other assessment systems, MapleTA can therefore test answers on semantic correctness, e.g. $1 + \tan(x)^2$ and $1/\cos(x)^2$ will both be recognized as proper first derivative of the $\tan(x)$ -function.

1 INTRODUCTION

In many places university teachers of engineering sciences observe similar facts about freshman.

- Engineering students should be intrinsically motivated to learn math. But they are not!
- Teachers face the problem to bore the good students and to overburden the others.
- Many students lack fundamental skills, like reading and understanding complex texts.
- There are deficits in mathematics stemming from the 7th or 8th grade. Starting with improper dealing of fractions, resulting in misconceptions on proper manipulations of terms.
- Many freshman are fixated on notations and methods they learned in school. E.g. "x stands for unknown" or using always the method of "completing squares" for solving quadratic equations.

The first and second point is interesting: Success in learning is strongly connected to motivation. If Spitzer (Spitzer, 2006) claims, "The brain is learning all the time," we could ask, "Why not math?"

This paper deals with an attempt to solve some of these problems. Obviously one solution could be the *hard one*: throw them out. Unfortunately, this does not meet our demands for more and better educated engineers. Selection is a concept for an oversupply of well educated candidates for engineering studies. This is not the case, especially for geomatics studies.

We observe a deviation between the development of curricula of schools and the needs of an academic education. And the situation will probably go worse. Christa Polaczek analyzed the curricula of the Bundesländer and found e.g. that equations containing fractions or logarithms are not explicitly mentioned in more than the half of the curricula (Polaczek, 2006). Consequently, other authors report about the decline of the mathematical "pre-knowledge" of first-year students and a strong relation to the final success in their study (Schwenk and Berger, 2006), (Polaczek, 2007).

1.1 Mathematical Assessments & Practice for Engineering Studies: Map@HCU

Our answer is a strong employment of computational mathematics combined with an extra tutorial conducted by a school teacher. The teacher has experiences in teaching the final grades of a German secondary school and is therefore well prepared for the needs of our freshmen.

After a diagnostic test in the beginning of the semester, we realized that nearly all of the the students needed a lot of practice and additional exercises. Unfortunately, we have only very little capacity to design and grade such exercises. The solution to this problem was to use a web based eAssessment system with automatic grading. Using this system makes it easier to introduce the concept of *formative assessment* (vs. *summative*) which states that the results of the accompanying assessments give an immediate feedback to the lecture. Not only the students get better but also the teacher! (Compare (Heck, 2004) and e.g. (http://en.wikipedia.org/wiki/Formative_assessment))

Another reason for a bad success rate in engineering sciences are wrong expectations of future students. Our plan is to offer self-tests for pupils and teachers. The aim is to make clear what we think students should know starting an engineering study. Right now, we test our eAssessments at a single school.

In the near future, we plan to use the eAssessment system not only for free self-study practice and homeworks but also for a replacement of the written examinations.

Because of the key role of the eAssessment system in our concept, we will discuss the possibilities and our choice in the next section.

2 E-ASSESSMENT SYSTEMS

In the beginning we looked for a web based system that could simply offer and grade mathematical questions with *infinite patience*. Therefore it needs the capability for in- and output of mathematical formulas, the dynamic generation of plots and the generation of random expressions and numbers. Most eLearning platforms (e.g. Blackboard, Moodle, StudIP etc.) offer some

eAssessment features but can only deal with numbers or static expressions. These systems can do a syntactical checking but understanding mathematical input (semantic checking) is far beyond the scope of such systems. The problem is that even a simple mathematical question can have an infinite amount of different correct answers.

2.1 Available Systems and Possibilities

Several solutions to these problems are available. The idea is to use a computer algebra system for the (possibly randomized) generation and grading of the questions.

Without intending to be exhaustive we quote only a few systems.

- An interesting project is *Active Math* (<http://www.activemath.org/>). The team around Erica Melis offers a complete math eLearning environment using elements of artificial intelligence including algebra systems. For our purpose the system is too complex and needs too much support but is still an interesting candidate.
- The project *Alice Interactive Mathematics* (AIM) (<http://caroll.ugent.be:8080/index.html>) is a web-based system designed to administer graded tests with mathematical content supported by the computer algebra system Maple. This Open Source Project (OSP) seems to be a little outdated at the moment but should be kept in mind.
- Another very promising OSP is the LON-CAPA system (<http://www.lon-capa.org/>), especially designed to offer eLearning courses and eAssessments with content from natural sciences and mathematics. The advantage is a huge and free available amount of repositories and a big user group.

Although each of the mentioned OSP eAssessment systems contain very interesting features, we decided to use the commercial MapleTA. The installation is relatively simple and the maintenance can be done completely via web. Additionally, we can use the full power of the underlying current Maple computer algebra system.

2.2 Maple TA

MapleTA is designed by Maplesoft Inc. in cooperation with Brownstone Research Group Inc. (<http://www.maplesoft.com>), (<http://www.wimba.com>). It combines a classical eAssessment system with typical question types as *Multiple Choice*, *Fill in the Blanks*, *Drag and Drop* and *Essay* with so called *Maple Graded Questions* which use the ability of Maple to check formula input for correctness. E.g. we could ask for the n th derivative of $\cos(x)$. Answers like

$$\cos\left(x + \frac{n\pi}{2}\right)$$

or

$$\cos(x) \cos\left(\frac{n\pi}{2}\right) - \sin(x) \sin\left(\frac{n\pi}{2}\right)$$

would both be detected correct. For details compare (Heck, 2004).

Additionally, questions can contain symbolic or numerical parameters, called *algorithmic variables*, which can be chosen randomly. Combining these parameters into mathematical terms yields dynamic expressions which can be plotted using Maple's plot facilities. Using this feature one can build question templates

Figure 1: Designing Algorithmic Variables

which look different each time they are called. In Figure 1 the designer for algorithmic variables and the resulting dynamic graphs are shown.

The questions are stored in so called *question banks* and possibly be shared with other instructors. The questions can be developed in a full graphic *question bank editor*. Alternatively a script language similar to HTML can be used or a special \LaTeX style which must be converted by Maplesoft. Compare Figure 2.

Figure 2: Editors's view

The particular assignment is then built using the *assignment editor*. One can choose question banks, assign weights (points) to the questions, order them randomly or even in a static order, choose the type of the assignment (e.g. self-study practice, homework, exam etc.), the time of availability and many other options.

The assignments can be done e.g. as homework using a standard browser or as exams in a controlled computer environment. So called *proctors* can check the authorization of the examinees and log them into the system.

The student's input can be immediately graded so that the student gets immediate response. Compare Figure 3. Note, that there is not only the correct answer but also several hints and comments to learn how the right answer could be achieved.

The results are stored in the so called *gradebooks*. They can be used for individual reports on students or for statistical purposes of groups or classes. Compare Figure 4.

Question Name: Absolute minimum

Find the absolute minimum value of $y = 4x^2 - 32x + 6$ on the interval $[0, 5]$

$y =$

Grade: 0%

Your response	Correct response
Find the absolute minimum value of $y = 4x^2 - 32x + 6$ on the interval $[0, 5]$	Find the absolute minimum value of $y = 4x^2 - 32x + 6$ on the interval $[0, 5]$
$y = 4$ (0%)	$y = -104$

Total grade: $0.0 \times 1/1 = 0\%$

Comment:

To solve this problem, you first have to calculate the value at which the absolute minimum occurs.

Take the derivative of y with respect to x .

$$\frac{d}{dx}(4x^2 - 32x + 6) = 8x - 32$$

Once you have the derivative, set it equal to zero and solve for x .

$$8x - 32 = 0$$

$$x = \frac{32}{8} = 4$$

This is the x -value that gives the absolute minimum.

Now, substitute the value of x back into the equation to determine the minimum value.

$$y = 4(4)^2 - 32(4) + 6$$

$$= 64 - 128 + 6$$

$$= -58$$

Figure 3: Response to a wrong Answer

Search Panel

Assignment Name: Homework 1 - Homework/Quiz

Assignment Type: Proctored

Show Results: Best

Completed/In Progress: Completed

Date Range: from: to:

View Panel

Assignment: Homework 1 - Homework/Quiz

Student: Last Name

Grade Style: Numeric

View Results For: All users

List: All users

Summary Data: Weights

Start date: Start time

End date: End time

Duration: # attempts

Student ID: Email

Submit

Item statistics

Students

Last Name	First Name	Grade	Grade	Grade	Grade	Total
Average Score		8.2	10.8	7.57	7.57	
Total Points		9	13	10	10	42
Jones	Andrea	9	11	9	8	8.0
Smith	Brian	8	10	8	6	6.0
Barnes	Cathy	-	9	5	6	6.0
Young	Doug	9	12	10	10	10.0
Fletcher	Frank	7	10	8	8	8.0
Henderson	Gretchen	8	11	9	9	9.0
Abbot	John	-	8	4	-	0.0

Figure 4: Instructor's View on the Gradebook

To access the system individual accounts must be arranged. Alternatively, an LDAP can be used or groups of users can be imported by an administrator using a simple roster.

3 SUMMARY

We discussed the problems of first-year students and tried to identify some of the reasons in schools and universities. We think that the introduction of eAssessment systems could help to overcome some of the problems in several ways. Diagnostic tests, self-studying practice with infinite patience and accompanying exercises are important elements at our university. But it is also important to get in touch with schools to find a common language, show the demands of engineering studies and last but not least motivate the young pupils to engage in mathematics, natural sciences and technology.

REFERENCES

Heck, A., 2004. Assessment with Maple t.a.: Creation of Test Items. <http://staff.science.uva.nl/~heck/CApub/MapleTA.pdf>.

Polaczek, C., 2006. Der Bildungsvorsprung beginnt in der Schule – ein Blick in die Bundesländer. In: Wismarer Frege-Reihe, Proc. 5. Workshop Mathematik für Ingenieure, Vol. 05 Teil 1, Hochschule Wismar, Frege-Institut, pp. 7–16.

Polaczek, C., 2007. Studienerfolg in den Ingenieurwissenschaften. In: Wismarer Frege-Reihe, Proc. Minisymposium. DMV Berlin 2007, Vol. 01 Teil 1, Hochschule Wismar, Frege-Institut, pp. 12–15.

Schwenk, A. and Berger, M., 2006. Mathematische Kenntnisse von Studienanfängern. In: J. Schlattmann (ed.), Bedeutung der Ingenieurpädagogik, Vol. 1, Der andere Verlag, pp. 86–92.

Spitzer, M., 2006. Lernen: Gehirnforschung und die Schule des Lebens. Spektrum Akademischer Verlag.

VISION TEACHLETS – WEB-BASED VISUALISATION OF ALGORITHMS IN PHOTOGRAMMETRY AND IMAGE ANALYSIS

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Commission VI, WG 1

KEY WORDS: Vision Teachlets, Visualisation, Interaction, Photogrammetric algorithms, Image analysis, Flash, Java

ABSTRACT:

The paper describes concepts and the realisation of vision teachlets for an interactive visualisation of algorithms in the field of photogrammetry and image analysis.

A series of web-based teachlets is being developed, which allow students to learn photogrammetric techniques without any temporal and spatial limitations. The teachlets are meant as an addendum to a lecture series, not as a stand-alone learning tool. Currently there are four vision teachlets accessible on the E-Learning webpage of the Chair of Photogrammetry at TU Dresden, which will be further extended:

- Cross correlation for finding homologous points in pairs of images
- Least squares matching of homologous points
- Space resection
- Morphological operations

The teachlets are developed platform independent in Adobe Flash and Java. The paper presents the features, the technique and the usage of these vision teachlets and will give an outline on our future activities in the field of E-Learning.

1. INTRODUCTION

The content of teaching in photogrammetry consists largely of methods and techniques, which are based on mathematical algorithms and image analysis methods. Traditionally, the algorithms are explained in lectures theoretically and examples are shown. In this way, the lecturer is restricted to the common presentation tools (PowerPoint, AVI-movie, Blackboard, OHP), whereby the interaction and thus the learning effect is often limited. Moreover, the individual speed of learning of students can be considered only insufficiently. In student exercises and project work the students use mainly commercial software packages, where the photogrammetric techniques are implemented, but their interior functionality is not open for the user.

Experience has shown, that the learning effect is much better, if students can 'play' with algorithms interactively in a visual environment (Höhle, 1997). The interaction is given through the possibility of uploading own (image) data and changing control parameters. The visualisation of the whole procedure, including intermediate steps and iterations as well as the results of the algorithms in a web-based tool allows the students to obtain a better understanding of complex algorithms. Furthermore, the use of own input data (e.g. digital images, laser scanner data) may increase the motivation of students significantly.

The advantages of interactive learning tools are also confirmed by (Shortis & König, 2008), which analyse a significant trend in education towards interactivity due to an improvement of the effectiveness and depth of learning. One example of a web-based digital photogrammetric software is presented by (Grussenmeyer et. al., 2002), which was developed in Java and is mainly dedicated to architectural photogrammetry and close range photogrammetry.

2. E-LEARNING PLATFORM

Students use more and more internet technologies for education purposes. They are used to discuss their experiences in web based forums, wikis and blogs. In order to consider this, our E-Learning platform is extended by a web forum, where students can communicate to each other, get in contact with teachers or report technical problems. Other students can benefit from these discussions and teachers are able to derive suggestions for the improvement of the E-Learning modules. In this way, the web forum serves as a simple evaluation tool. The development of more specific evaluation tools for the E-learning platform, particularly for the developed vision teachlets, will be implemented in future work.

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The screenshot displays the 'cross correlation' teachlet interface. At the top, the TU Dresden logo and navigation menu are visible. The main window is titled 'E-LEARNING » TEACHLETS » KREUZKORRELATION'. It features two side-by-side aerial photographs of a city street. The left image has a green bounding box, and the right image has a red bounding box. Below the images is a control panel with 'options' for window size (21, 41, 61), visualization mode (line, area), delay (1 ms), and speed (100). There are 'Start', 'Stop', and 'Restart' buttons. To the right of the control panel is a small window showing the cross correlation coefficient, which is 0.9833 (highest 1). A sidebar on the right contains 'NAVIGATION' links and a 'TEACHLETS' list including 'Kreuzkorrelation', 'Least Squares Matching (LSM)', and 'Mathematische Morphologie'.

Figure 1. Implementation of the vision teachlet ‘cross correlation’ on the E-learning platform (<http://www.tu-dresden.de/ipf/photo/e-learning>)

In addition to the vision teachlets, a viewer for 3D point clouds as well as a video viewer is available on the E-Learning platform of the Chair of Photogrammetry at TU Dresden. As one of our main research topics is the automatic analysis of terrestrial and airborne laser scanner data, the 3D point cloud viewer offers students and teachers a simple possibility to visualize 3D point clouds or results of point cloud processing algorithms. The video viewer allows for presenting video tutorials (e.g. screen videos explaining how to control a vision teachlet) or photogrammetric results, generated by students in exercises and seminars (e.g. virtual reality animations). One main goal of the developments is to connect the different E-Learning modules to a suitable network. This means to define interfaces between the vision teachlets themselves and vision teachlets with the video and 3D point cloud viewer. This also means to connect the E-learning modules with the lectures and seminars. For example the vision teachlets contain links to the corresponding positions of the lecture manuscripts, which are also available online for the students. Vice versa, the vision teachlets are introduced in the lectures.

The E-Learning platform aims to have a logical structure and a consistent design. Fig. 1 shows the vision teachlet “cross correlation” implemented on the E-learning platform of the Chair of Photogrammetry, presented using the corporate design of TU Dresden.

3. VISION TEACHLETS

The vision teachlets are developed platform-independent, which means they work on each popular Web browser (e.g. Firefox, Internet Explorer, Safari, ...) and operation system (e.g. Windows, Linux, Mac OS) without any uncommon plug-in. Therefore they are generated in Java or Adobe Flash, since these are widely-used techniques (see section 4).

Basic features of the existing vision teachlets and those which are still being developed are:

- Import possibilities for user data (digital images, 3D point clouds, etc.)
- Visualisation of the data (plausibility check)
- Possibility to change control parameters
- Visualisation of intermediate steps of the algorithms
- Control of processing speed (slow-motion function)
- Visualisation of results
- Export possibilities for results (graphical/numerical)
- Explanations, literature references

The modules are not access controlled. They are open for each web user, particularly students from other courses and universities. It is planned to implement a user registration in order to be able to document the usage of the teachlets to be considered for further developments.

The teachlet design is not clearly defined in the current status. Due to the different algorithms and developers it is hardly possible to define homogeneous specifications regarding

usability and design. The definition of such specifications is therefore restricted to a minimal overlap (e.g. colours, font sizes).

In the following, 4 different vision teachlets, which are currently available, will be presented as examples.

3.1 Cross correlation

The vision teachlet “cross correlation” (Fig. 1) is developed in Adobe Flash. It visualizes the principle functionality of cross correlation using different image pairs. It calculates the correlation coefficient matrix of a image template – defined in a first image – with a second image. Therefore it can be used to find corresponding points in image pairs.

Currently the user can choose between 6 different image pairs. The upload possibility of user data will be implemented in a next step. The user is able to control:

- size of the image template
- position of the image template in the first image
- visualisation mode of correlation coefficient matrix (linear, logarithmic)
- speed and delay of the algorithm (slow-motion function)
- search direction (linear, helical).

3.2 Least squares matching

Unlike the previous vision teachlet, this teachlet is produced in Java. Therefore the user has to install the Java environment on his computer and activate it in the web browser. The teachlet (Fig. 2) calculates the parameters of a least squares matching. In an iterative algorithm the geometric transformation parameters (translation, rotation, scale, shear) are processed between an image template of a reference image and an image template of a search image by minimising the least-squares sum of pixel value differences between both images. The positions of the image templates can be selected manually. Features of the teachlet are:

- upload possibility of image pairs
- controlling of the size of the image template
- controlling of the maximum number of iterations (in case of a failing convergence of the iterative process)
- visualisation of the convergence in a diagram (translation parameters exemplary)
- visualisation of the template deformation

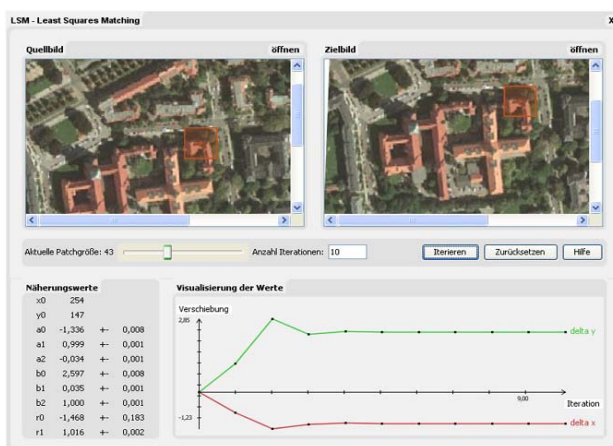


Figure 2. Vision teachlet ‘Least squares matching’

3.3 Space resection

This teachlet (Fig. 3) is realised as a Java Applet. It calculates the exterior and interior orientation, as well as (if desired) additional camera calibration parameters in a least squares adjustment. The user can either chose between two available projects or upload own data. There are examples for user data (coordinate file, parameter file) available for download which define the data format. The teachlet integrates the following features:

- two example projects
- possibility to upload user data
- possibility to select parameters to be estimated in the adjustment
- definition of approximate values
- possibility to select or deselect points
- display of exterior, interior orientation parameters as well as additional camera calibration parameters
- visualization of image coordinate residuals for each iteration step (scalable length) as overlay of the original image (if available)

This vision teachlet contains several information buttons behind each parameter explaining the scientific background of the algorithm. It is planned to implement a tool for interactive image point measurements as well.

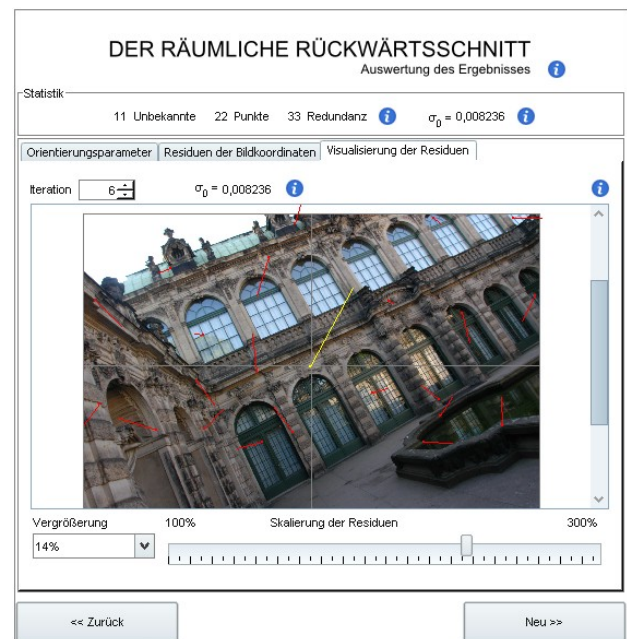


Figure 3. Vision teachlet ‘Space resection’

3.4 Morphological operations

This vision teachlet (Fig. 4) is developed in Adobe Flash and visualizes the functionality of different morphological operations (dilatation, erosion, opening, closing) as well as the functionality of connectivity analysis. It is possible to select pixels manually which are white (on black background) in order to draw 2D objects with arbitrary shapes. The upload of user data (images) and subsequently the implementation of the

binarisation of these images is planned. The following parameters can be controlled by the user:

- size of the image grid (number of columns and rows)
- delay of the algorithm (slow-motion function)
- shape of the morphological structure element (cross or square)
- size of the morphological structure element
- type of morphology
- connectivity neighbourhood (4 or 8 pixel)

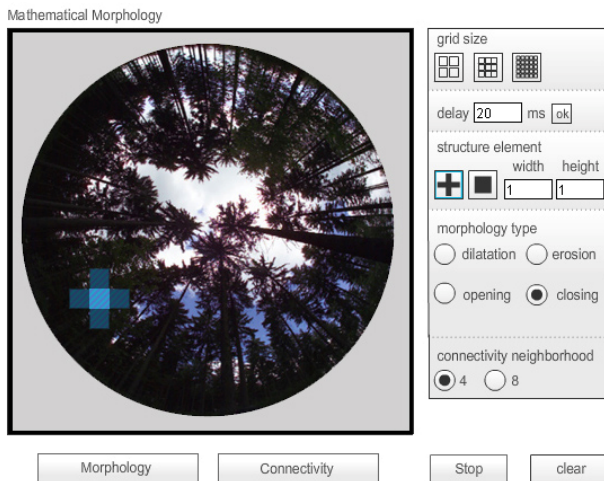


Figure 4. Vision teachlet 'Mathematical morphology'

3.5 3D Viewer and video viewer

As an extension to the vision teachlets presented above there was a viewer for 3D point clouds developed in Adobe Flash (Fig. 5). The viewer allows for an interactive navigation in the point cloud (translation, rotation, zoom). The point clouds are produced e.g. in student exercises with a terrestrial laser scanner. The performance of this Flash viewer is currently limited to ca. 5000 points. Therefore the possibilities of the Java 3D technology for a web-based point cloud viewer is currently investigated. It is planned to implement data analyse functions (e.g. measuring of distances, filtering, 3D object fitting).

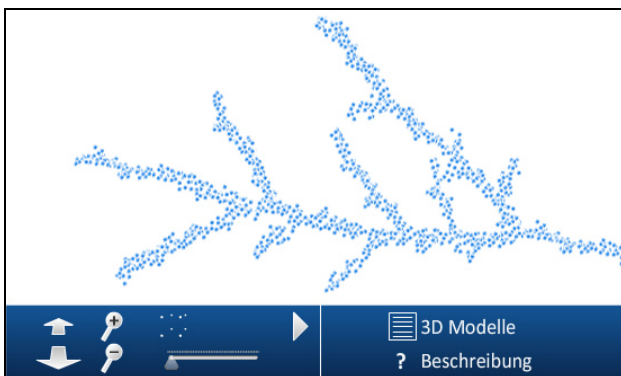


Figure 5. Interactive 3D Viewer (showing a laser scanner point cloud of a branch)

The video viewer was also developed in Adobe Flash. The user can switch between several videos which can be uploaded to the web server via a simple user interface. The video viewer shows photogrammetric products (e.g. virtual reality animations) or screen videos (e.g. vision tutorials which document the usage of vision teachlets) together with a description of the video in text form.

4. TECHNICAL BACKGROUND

Currently we use Adobe Flash and Java to implement the teachlets since both formats are platform and browser independent allowing a wide user base to see the teachlets. Flash is available on over 99% of user clients (Adobe Systems, 2009), and comes with a huge set of given functionality that makes it easy to interact with the user (e.g. user interface components). On the downside, Flash uses Actionscript as a programming language for which many freely available photogrammetric algorithms are not available and therefore need to be converted.

Java is enabled on about 90% of user clients (The counter.com, 2009), and some free photogrammetric algorithms are already available. Using Java, teachlets can be integrated on the web page as applets, or they can be opened as stand-alone applications using Java Web Start.

In future work we will also investigate in other techniques to write and integrate applets such as Microsoft Silverlight, Adobe Shockwave and JavaScript.

5. FUTURE PROSPECTS

5.1 Vision teachlets under development

There are different vision teachlets under development which will be integrated within the E-learning platform shortly. These teachlets visualize the following algorithms:

- Hough transform
- Relative orientation of stereo images
- Epipolar line geometry

Other algorithms are planned to be implemented in future work:

- Image rectification
- Camera calibration
- Spatial intersection
- Direct georeferencing of aerial images
- Multispectral classification

5.2 Features to be implemented

The future developments will focus on interfaces between the vision teachlets, on upload and download possibilities for user data, on more homogeneous design and usability as well as on integrated evaluation tools in order to allow for specific improvements of the E-learning modules.

6. CONCLUSIONS

The presented platform can be characterized as our first steps in the field of E-Learning. It is used to gain experiences regarding the technical background and the effectiveness in its usage in the photogrammetric education. It is still in an experimental status and will be further developed in future work.

7. ACKNOWLEDGEMENT

The future developments of our E-Learning platform are funded by the Multi Media Fond of the Media Center of the TU Dresden under the project title "Vision Teachlets – Webbasierte Visualisierung von Algorithmen aus Photogrammetrie und Bildanalyse".

8. REFERENCES

Adobe Systems, 2009. Adobe Flash Player Version Penetration – Worldwide Ubiquity of Adobe Flash Player by Version – March 2009. http://www.adobe.com/products/player_census/flashplayer/version_penetration.html (accessed 8 May 2009).

Grussenmeyer, P., Drap, P. and Gaillard, G., 2002. ARPENTEUR 3.0: Recent developments in web based photogrammetry. *Int. Arch. of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 34(6): 141-146.

Höhle, J., 1997. Computer-assisted teaching and learning in photogrammetry. *ISPRS Journal of Photogrammetry and Remote Sensing*, 52(6): 266-276.

Schneider, D., 2009. E-Learning-Portal der Professur für Photogrammetrie. Technische Universität Dresden. <http://www.tu-dresden.de/ipf/photo/e-learning/> (accessed 8 May 2009).

Shortis, M.R. & König, G., 2008. Computer aided teaching in photogrammetry, remote sensing and GIS – A status review. Proceedings of XXI ISPRS Congress, Beijing, China. *International archives of Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII, Part B6*.

The counter.com, 2009. Java Statics. WebMediaBrands Inc., <http://www.thecounter.com/stats/2009/March/java.php> (accessed 8 May 2009).

GIS-RELATED WEB ENGINEERING AS TOPIC AND TOOL IN E-LEARNING

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Commission VI, WG VI/1-2

KEY WORDS: e-learning, geoinformatics, web engineering, web services, earth viewers, AJAX, SVG

ABSTRACT:

In the last few years, map viewers like Google Maps, Microsoft Live Search Maps and Open Street Map as well as virtual earth viewers like Google Earth and Microsoft Virtual Earth had an important impact on the development and dissemination of Internet-based GIS applications. Therefore, there is a vital need for knowledge about the techniques required for exploiting and developing such applications. The e-learning module “Web Engineering in the Geoinformatics” offers an unbiased introduction into this field. The module was developed within the current project “FerGI+” (Fernstudienmaterialien Geoinformatik; English: distance learning material for geoinformatics) for teaching students of geoinformatics, geodesy, geography and environmental sciences in a blended learning scenario as well as for participants of further education programs. It covers technologies like the Google Maps API, AJAX (Asynchronous JavaScript and XML), the OpenLayers API, OGC KML and SVG (Scalable Vector Graphics). The e-learning material is provided via HTML and a Moodle e-learning platform. The use of HTML allows a direct integration and visualization of the presented technologies into the e-learning material. The code required for the integration of a Google Maps or an OpenLayers application into a web page can be presented together with the resulting live map. An effective learning process demands changing between gaining new competences and using them in exercises in a high frequency. For this purpose, the students can modify given JavaScript functions within the HTML pages in order to work out the presented content. If it is done correctly, the resulting maps or SVG images are immediately visualized.

1. INTRODUCTION

In the recent years, providing geospatial information via Internet and World Wide Web (WWW) became increasingly important. Most popular are proprietary, but free-of-charge online *map services* like Google Maps and Microsoft Live Search Maps as well as *earth viewers* like Google Maps and Microsoft Virtual Earth. They cover the whole earth's surface by street and topographic maps as well as by aerial and satellite images. On top of these services, many so called *mashups* were implemented, i.e., web sites that seamlessly combine content from more than one source into a single integrated application. Following this development, projects of the open-source community gained attention: Open Street Map and OpenLayers are prominent examples.

One important consequence of this development is a vital need for knowledge about the techniques required for exploiting and developing such web applications. For this purpose, the new e-learning module “Web Engineering in the Geoinformatics” offers an introduction into this field. It covers technologies like the Google Maps API, AJAX (Asynchronous JavaScript and XML), the OpenLayers API, OGC KML and SVG (Scalable Vector Graphics). In addition of being subject of the module, many of these technologies are used for the development of interactive e-learning material. In other words, they are used as topic and as tool in e-learning.

The rest of the paper is organized as follows: After a short presentation of the FerGI+ project the main contents of the module are presented. The fourth section discusses how the outlined techniques can be used as tool for visualization

purposes and for supporting modifications of exemplary source code. The paper concludes with a short summary and an outlook to future work.

2. THE FERGI+-PROJECT

The project “FerGI+” started in April 2007 and was finished in March 2009 as a cooperative project of the University of Osnabrück and the Universities of Applied Sciences in Oldenburg and Osnabrück (Grendus et al., 2009). It was funded by the Ministry for Science and Culture of Lower Saxony during the third phase of the “eLearning Academic Network Niedersachsen” (ELAN III). During those two years, ten eLearning modules were developed. “FerGI+” is the successor of the well-known “FerGI” project (Schiewe et al., 2006); it broadens the range of offered e-learning modules. The contents of the modules are given in German and / or in English. An overview of the available FerGI(+) modules is given in figure 1. More information about FerGI+ can be found at <http://www.fergi-online.de>.

The FerGI(+) modules do not reflect the whole GI-curriculum, but concentrate on special GI-topics with high topicality. They are primarily used in blended-learning scenarios at universities, i.e. by a combination of long-distance learning and face-to-face learning. In addition, the modules are offered to all interested parties from administration, industry, schools and universities. An eight-week free-of-charge access to the modules is provided after a registration. Also special FerGI-based further education program exists for small companies that certificates successful attendance (Grendus, 2008).



Figure 1. Overview of the FerGI (without star) and FerGI+ modules (with star)

The Institute for Applied Photogrammetry and Geoinformatics (IAPG) of the University of Applied Sciences in Oldenburg developed five modules during the FerGI project (Krüger & Brinkhoff, 2005). For FerGI+, the three following modules were implemented:

- “Computational Geometry in the Geoinformatics”,
- “Data Structures and Algorithms for Spatial Database Systems”, and
- “Web Engineering in the Geoinformatics”.

The modules are provided via the WWW using simple and widespread techniques like HTML, CSS, JavaScript, PHP and Flash. This allows a simple integration of the modules into the technical infrastructure and the preferred (or forced) e-learning platforms of the universities like Moodle or ILIAS. In addition, a pure HTML version without the need of using an e-learning platform is offered.

3. CONTENTS OF THE MODULE “WEB ENGINEERING IN THE GEOINFORMATICS”

The overall topic of the e-learning module „Web Engineering in the Geoinformatics“ is the creation of web-based map applications by using proprietary and free-of-charge online map services. It covers also data formats like OGC KML and SVG and web technologies like AJAX that are relevant for the development of such applications. These topics are especially suitable for e-learning because they do not need only to be presented in an abstract way but can be directly exemplified by using the presented techniques.

3.1 Earth Viewers

Online map services, which provide beside data (like maps and images) the required user control elements (like navigation controls and layer controls), are often called *earth viewers*. Typically, *web mapping systems* and *3D clients* are distinguished. Whereas web mapping systems can be used within ordinary web browsers, 3D client systems require the installation of additional software on the user's local computer. They are typically offering a three-dimensional view of the

earth as *virtual globe*. Both types of earth viewers provide the data on demand using streaming technology.

Among the most important providers of earth viewers are Google (Google Maps and Google Earth), Microsoft (Live Search Maps) and the NASA (World Wind). Their competition leads to a steady extension of the functionality and improvement of the usability of the viewers as well as to maps, images and photos of increased resolution and coverage.

A very important feature of the services mentioned above are their open *application programming interfaces (APIs)*. They allow incorporating the maps, images and user control elements into other web pages. Furthermore, it is possible to overlay these data by own geospatial data or other datasets loaded from the Internet. Most of the current so-called mashups are based on the API of Google Maps (ProgrammableWeb, 2009).

The module „Web Engineering in the Geoinformatics“ starts with an overview about existing online map services like Google Earth (see figure 2), Microsoft Live Search Maps / Virtual Earth API (figure 3), NASA World Wind and Open Street Map. Then, it presents two services in more detail: Google Maps and OpenLayers.



Figure 2. Integrated video about Google Earth and web links to articles and examples

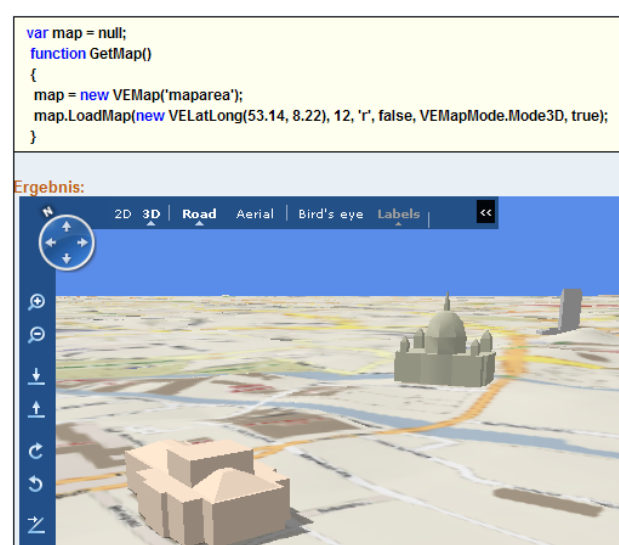


Figure 3. Explanation of the use of the Virtual Earth API and the result

3.1.1 Google Maps: In case of *Google Maps*, especially its API is explained (Google, 2009). The Google Maps API is a JavaScript library, which can be used with an individual API key requiring a free-of-charge registration at Google. The use of different map types, of user controls, of (user-defined and WMS) overlays and of geo-coding are outlined by the module (see figure 4). Like other proprietary map services, the Google Maps API supports only the use of Google-specific maps and images as background map.



Figure 4. An animation that illustrates the different layers of a Google Maps application

3.1.2 OpenLayers: *OpenLayers* is a free JavaScript library that allows integrating multiple map services into a web page (OpenLayers, 2009). It consequently separates the map controls from the map data. Therefore, the controls can be used for different data sources. Beside OGC-compliant web services, proprietary services, e.g., of Google, Microsoft and Yahoo and vector data and markers can be integrated. The module introduces the OpenLayers API and especially discusses the use of control elements, of different layer classes and the combination of proprietary and OGC-compliant services (see figure 5).

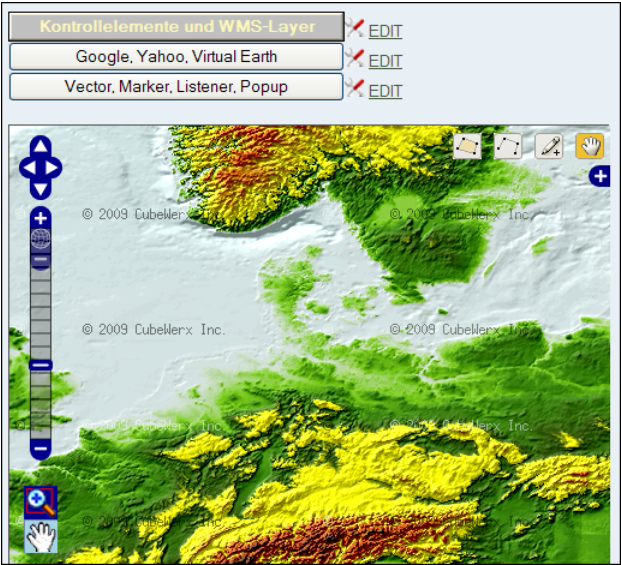


Figure 5. Exemplary OpenLayers application illustrating the integration of different data sources

3.2 Data Standards

The module „Web Engineering in the Geoinformatics“ covers two important data formats for geospatial web applications: OGC KML and SVG.

3.2.1 OGC KML: *OGC KML* (v2.2) is the successor of the KML 2.1 specification of Google (Wilson, 2008). It is a combined representation and visualization format for simple geometries. The e-learning module describes the data model for geometries, geospatial features and their styling (see figure 6).

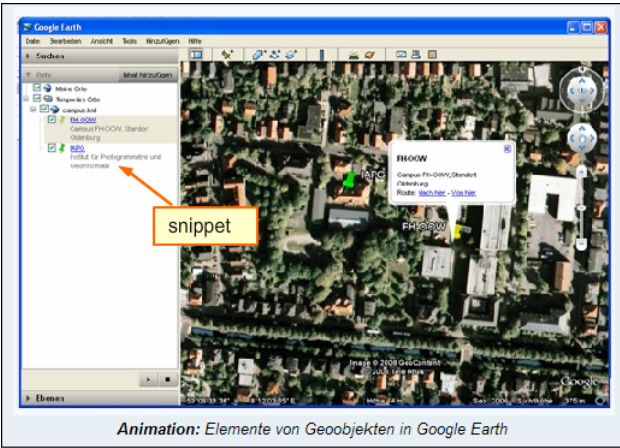


Figure 6. An animation that illustrates the elements of OGC KML features

T (absolut) t (relativ)	(x y)+	Shorthand/smooth quadratic Bézier curveto: zeichnet eine quadratische Bézierkurve vom aktuellen Punkt zu der gegebenen (x,y)-Koordinate. Als Kontrollpunkt wird die Reflexion (bezüglich des aktuellen Punktes) des Kontrollpunktes der vorherigen Kurve verwendet.
A (absolut) a (relativ)	(rx ry x-axis-rotation large-arc-flag sweep-flag x y)+	elliptical arc: zeichnet einen elliptischen Bogen vom aktuellen Punkt zu der gegebenen (x,y)-Koordinate. Die Radien der Ellipse werden über rx und ry angegeben. Über x-axis-rotation wird die Drehung der Ellipse im aktuellen Koordinatensystem definiert. Mit large-arc-flag (größere Bogen?) und sweep-flag (obere oder untere Bogen?) wird eindeutig bestimmt, welcher Bogen der Ellipse gezeichnet wird.

Beispiele

Beispiel:

```
<path d="M50 70 L150 70 L100 200 z"
fill="red" stroke="blue">
<path d="M50 70 Q100 50 150 70 Q100 140 100 200
Q100 140 50 70" fill="green" stroke="yellow"
transform="translate(120)">
<path d="M340 70 A40 40 0 0 1 340 200 A40 40 0 0 1 340 70 z
M340 100 A20 20 0 0 1 340 170 A20 20 0 0 1 340 100 z"
fill-rule="evenodd" fill="blue" stroke="orange">
```

Resultat: EDIT

Figure 7. Explanation, example and illustration of the SVG path element

3.2.2 SVG: Scalable Vector Graphics (SVG) (W3C, 2003) is an XML-based data format for two-dimensional vector graphics. It was developed by the WWW consortium especially for web applications. SVG is popular for displaying maps (Ueberschär & Winter, 2006), e.g., it can be the result format of WMS services. There are several reasons for its popularity for geospatial applications: SVG supports scaling, coordinate systems, and transformations. Furthermore, the document object model (DOM) of SVG allows accessing and modifying SVG elements and their attributes for implementing interactive map applications.

The e-learning module (see also figure 7) introduces the structure of SVG documents, coordinate systems, simple and complex geometry types, text and image elements, as well as the styling of those elements. More advanced topics are animations, scripting, the handling of mouse events and container elements.

3.3 Web Technologies: AJAX

One of the most important web technologies for interactive web applications is *AJAX* (Asynchronous JavaScript and XML). It is a technique for the asynchronous communication between a web server and a client application executed in a web browser. The communication is performed via the HTTP protocol. HTTP is a stateless protocol, i.e. the web browser expects for each request a response that is displayed by the browser. In case of interactive web applications this behavior leads to undesirable blockades and refreshing of displayed pages. AJAX bundles a clutch of techniques that allow performing an HTTP request and processing its result asynchronously without a complete reloading of the current page. AJAX allows the development of web applications that behaves similarly like traditional desktop applications. In case of a map application, e.g., spatial data can be requested subsequently and integrated into an already displayed map.

In the module „Web Engineering in the Geoinformatics“, the concept of AJAX is outlined as stand-alone solution as well as integrated into the Google Maps API (Purvis et al., 2006) (figure 8).

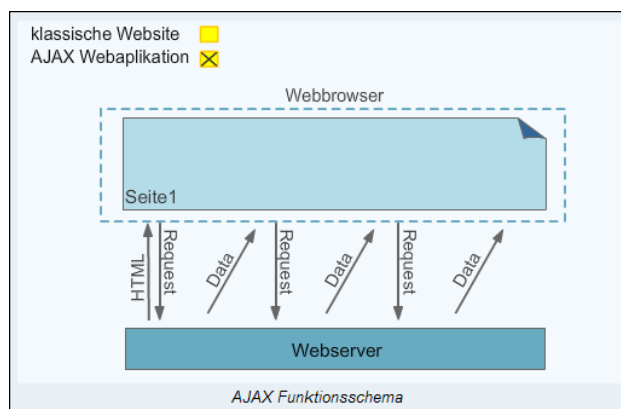


Figure 8. Animation that illustrates the functioning of traditional web requests and of AJAX

4. GIS-RELATED WEB ENGINEERING TECHNIQUES AS TOOL

The FerGI+ modules are realized by HTML. Therefore, a direct integration and visualization of the presented technologies into the e-learning material is possible. For example, the code required for the integration of a Google Maps or an OpenLayers application into a web page can be presented together with the resulting live map. Figures 3 and 5 illustrate such examples.

Furthermore, the students should be enabled to apply more examples directly and see the results. In the context of a web browser, this can easily be achieved by prepared links and calls of prepared JavaScript functions. The three upper buttons in figure 5 are examples for such an approach.

An effective learning process demands changing between gaining new competences and using them in exercises in a high frequency (Strobl, 2004). Therefore, the students should apply their new knowledge in modified contexts, e.g., for changed requirements or objectives. For this purpose, the students are enabled to modify given JavaScript functions or to create new code within the presented HTML pages. For a suitable feedback, the modified or new code will be evaluated straight away. In our context that means – if the programming is done correctly – the resulting map (or SVG image) is immediately visualized using the given JavaScript libraries and available map services.

All three variants of integration of the web engineering technologies are used in the chapters about the Google Maps API, about the OpenLayers API and about SVG.

4.1 Integration of the APIs for an Exemplary Visualization

The integration of the APIs for exemplary visualization purposes is done in all cases similarly by adapting or providing three different documents: the containing HTML page, a controlling JavaScript document and a CSS document for styling purposes.

The HTML document is added by (see also figure 9):

- a reference to the required JavaScript libraries (plus a registration key if necessary),
- an initialization of the service (typically by calling the initialization function via the `onLoad` event handler), and
- a container element for the map (typically a `div` element that is identified by an ID).

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Google Maps</title>
<link href="style.css" rel="stylesheet" type="text/css"/>

<script src=
"http://maps.google.com/maps?file=api&v=2&key=XXX"
type="text/javascript"></script> // The library reference
<script src="script.js" type="text/javascript"></script>

</head>
<body onload="load()" // The initialization
<h1>The Map</h1>
<div id="maparea"></div> // The map container
</body>
</html>
```

Figure 9. The augmented HTML document in case of the Google Maps API

The JavaScript document is the component that controls the API functionality. There is typically a central class representing the map. Its constructor is parameterized by the ID of the container in the HTML page that should accommodate the map (figure 10).

```
var map = null;
var start_y = 53.13884;
var start_x = 8.214575;
var start_zoomlevel = 12;

// Initialization
function load() {
  if (!GBrowsersCompatible()) {
    alert("The browser is not compatible for Google Maps!");
    return;
  }
  // Create map object
  map = new GMap2(document.getElementById("maparea"));
  // Define the center of the map
  map.setCenter(new GLatLng(start_y, start_x, start_zoomlevel);
}
```

Figure 10. The controlling JavaScript document

4.2 The Support of Code Modifications

For modifying exemplary code, a corresponding *code editor* was developed. In contrast to the code fragments depicted within the learning material, the editor requires the complete code of an example. The editor is called by “EDIT” links that reference a corresponding code file; the figures 5 and 7 depict such links. Triggering such link opens the editor and loads the corresponding code into the included input area. Modifications are directly evaluated by the JavaScript interpreter of the web browser. The corresponding results (or error messages if case of incorrect code) are immediately visualized. Figure 12 illustrates this process.

The editor is realized by using HTML frames. That allows the user to vary the size of the input area and of the result area. Figure 11 shows the functionality of the editor.

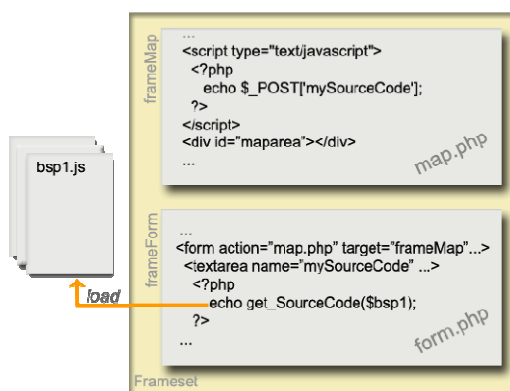


Figure 11. Functionality of the editor in case of maps

The same approach can be applied for the editing and the visualisation of SVG documents. In contrast to the map APIs, the upper area of the editor is not an HTML file but an XML file that can be directly evaluated by the web browser (if it has a native SVG support like Mozilla Firefox) or by a plug-in of the

web browser (like in the case of Microsoft's Internet Explorer). Figure 13 illustrates this approach.

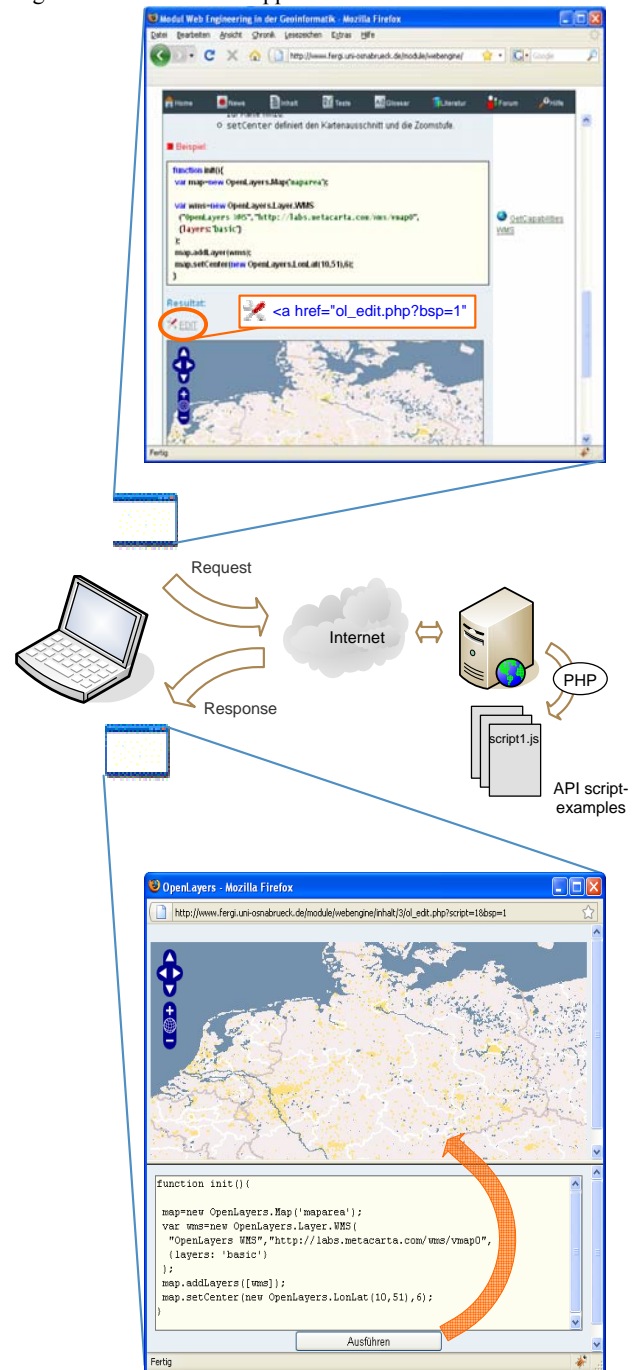


Figure 12. Calling the editor and executing code modifications

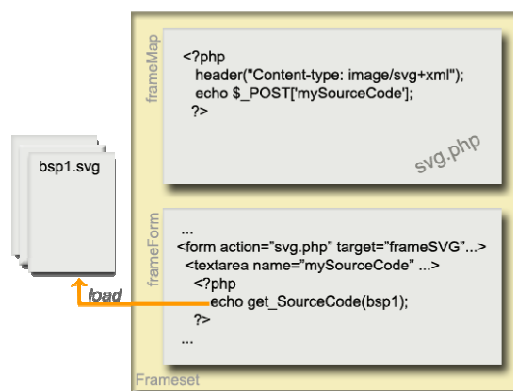


Figure 13. Functionality of the editor in case of SVG

5. CONCLUSIONS

Web engineering in the fields of computer science and geoinformatics is nowadays a very broad and fast developing area. Therefore, it is not possible to include all relevant topics into a single e-learning module. Consequently, the presented module “Web Engineering in the Geoinformatics” introduces into a selection of techniques that are of high relevance for web-based map applications. Of further relevance was their suitability for thematic and technical restrictions of the FerGI+ project. As mentioned before, FerGI(+) modules do not reflect the whole GI-curriculum, but concentrate on the design, evaluation and deployment of modules that cover ongoing and applied topics.

Interactivity is in general a very important aspect in online learning environments compared to conventional lectures and books. By interactive animations, the time of learning can be shortened and the comprehension can be increased. Therefore, FerGI(+) modules consist of interactive Flash and SVG animations, Java applets and other comparable elements. For special themes, the development of specific tools can be necessary. For example, in favor of the modules about spatial databases a SQL tool is provided that visualizes stored and retrieved spatial data relations (Krüger & Brinkhoff, 2005). In case of the module “Web Engineering in the Geoinformatics”, the presented editor allows an interactivity that exceeds the potential of normal animations. New skills can be directly exercised and broadened.

An important aspect of the development and provision of e-learning material is to guarantee their sustainability (Krüger et al., 2006). In case of FerGI(+) modules, this goal shall be achieved by a cooperation with the society “Geoinformatics in Northern Germany” (GiN). GiN operates the e-learning platform and the portal to the FerGI(+) e-learning modules. The society is also in charge for marketing, quality and right management. The cooperating universities are responsible for updating the material. In future, the integration of the modules into the curricula of the cooperating and other universities should be intensified. Only a regular use of the modules within the universities will guarantee their regular update.

REFERENCES

- Google Inc., 2009. „Google Maps API Concepts”. <http://code.google.com/intl/en/apis/maps/documentation/> (accessed 15 May 2009)
- Grendus, B., 2008. FerGI@KMU: Berufliche, zertifizierte Weiterbildung mit E-Learning-Modulen zur Geoinformatik. *Proceedings of the logOS 2008 „Lernen, Organisation, Gesellschaft - Das eCampus-Symposium der Osnabrücker Hochschulen“*, Osnabrück, Germany, pp. 19-23.
- Grendus, B., Schiewe, J., Ehlers, M., 2009. Ein Konzept zur nachhaltigen Sicherung und Pflege von E-Learning-Modulen für die Geoinformatik unter dem Aspekt von Vermarktung und Kooperation. In: Appellath, H.-J., Schulze, L. (eds.): *Auf dem Weg zu exzellentem E-Learning: Vernetzung und Kooperation der Hochschullehre in Niedersachsen*, Waxmann, chap. 17.
- Krüger, A., Brinkhoff, T., 2005. Spatial Data Management - Development of e-Learning Modules. *Proceedings 8th AGILE Conference on Geographic Information Science*, Estoril, Portugal, 2005, pp. 207-214.
- Krüger, A., Brinkhoff, T., Grendus, B., 2006. Towards a Sustainable e-Learning Solution for GI-Education. In: *Proceedings ISPRS TC VI Symposium “e-Learning and the Next Steps for Education”*, Tokyo, Japan, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science, Volume XXXVI, Part 6, 2006, pp. 71-75.
- OpenLayers, 2009. “OpenLayers: Free Maps for the Web”. <http://openlayers.org/> (accessed 15 May 2009)
- ProgrammableWeb, 2009. “Mashups Tag Search: mapping”. <http://www.programmableweb.com/tag/mapping> (accessed 15 May 2009)
- Purvis, M., Sambells, J., Turner, C., 2006. *Google Maps Applications with PHP and Ajax*, apress, 384pp.
- Schiewe, J., Hödl, T., Grendus, B., 2006. FerGI: Innovative E-Learning-Materialien zur Aus- und Weiterbildung in Photogrammetrie und Fernerkundung. In: Seyfert, E. (ed.): *Publikation der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation e.V.*, Band 15, Berlin.
- Strobl, J., 2004. Erfolgsfaktoren für e-Learning – Lebenslanges Lernen mit Online-Medien. In: Schiewe, J. (ed.): *E-Learning in Geoinformatik und Fernerkundung*, Wichmann Verlag, Heidelberg, pp. 3-10.
- Ueberschär N., Winter, A., (2006). *Visualisieren von Geodaten mit SVG im Internet*. Wichmann Verlag, Heidelberg.
- W3C, 2003. “Scalable Vector Graphics (SVG) 1.1 Specification”. <http://www.w3.org/TR/SVG11/> (accessed 15 May 2009)
- Wilson, T. (ed.), 2008. *OGC KML*. OGC standard 07-147r2, 2008-04-14, 251pp.

STATISTICAL DATA ANALYSIS AND MODELING OF SKIN DISEASES

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Commission VI, WG VI/1, VI/2

Key words: E-learning, statistical data, analysis and modeling, skin diseases, CSR tests

Abstract:

Skin diseases are categorized in different types and one type which we deal with is a kind of fungus infections on the skin. This spotted pattern makes their home in moist area of the body where the skin is wet, between toes, under the breasts, or on sternum skin, under the neck. In this paper we focus on to the later part of the skin which in men is exposed to the pendant ingredients in the air (polluted air).

In this research we do not go to the medicine treatment aspects and only concentrate on the spatial distribution of spotted pattern on the surface of the skin. We take the photo of infected part of the skin and assign a coordinate system to the spots in order to explore the density of them. The point pattern of the spot's spatial distribution is tested if it is random, regular, or clustered. The exploration and modeling of the point pattern could help developing appropriate treatment and amount of the medicine to be applied, especially making advises through e-media, e.g. e-mail.

As the science in every aspect is developed, the population of our planet is increased. Trading, traveling, and immigrating are the main ways of spreading diseases from city to city, state to state, country to country, and definitely continent to continent. Hence we need the easiest, fastest, and cheapest way of treatment. Certainly e-treatment can serve in this way.

Our data is a photo of skin infected by spotted pattern. We marked the spots with red circle in order to transfer the photo to software with appropriate coordinate system to read the coordinates of spots to be put in database. We analyze the spotted pattern regardless of the type of disease, even if the initiative search leads us to name the type of disease "fungus", which does not goes deep in the skin.

To visualize data, first we use quadrat density method in R. What we gain from quadrat method helps to get a general idea of the distribution and density of point pattern on the skin surface. What we perceive from this process and analysis is the intensity of point pattern on skin which is exposed to the pendant ingredients in the air.

Then we use kernel estimation to obtain a smooth estimate of probability density from the observed area and do nearest neighbor distance tests for Complete Spatial Randomness (CSR). Moreover the CSR test is applied by using K-function and L-function for the red signs to see if the observed pattern is clustered, regular or random. CSR tests indicate clustering in red signs. The most infected areas on the skin (indicating clustering) are exposed to the pendant ingredients and polluted air which normally is not covered by cloths.

Concluding, in our case study, we focus on skin diseases with the aid of E-learning in spatial data analysis and modeling for any decision to be taken by the physicians/doctors in order to reduce the time of treatment and the amount of medicine to be used. The treatment can be done form distance in a reliable way.

1- Introduction:

Skin diseases are categorized in different types and one type which we deal with is a kind of fungus infections on the skin. This point pattern makes their home in moist area of the body where the skin is wet, between toes, under the breasts, or on sternum skin, under the neck. In this paper we focus on to the

later part of the skin in which men is exposed to the pendant ingredients in the air (polluted air).

In this research we do not go to the medicine treatment aspects and only concentrate on the spatial distribution of point pattern

on the surface of the skin. We take the photo of infected part of the skin and then assign the spots to a coordinate system in order to test if the density and distribution of the point pattern is random, regular, or clustered.

Our assumption is that this could provide useful information in medicine for making decisions about the treatment and required amount of the medicine. Hence the main research questions are:

Do the sick have to use the medicine equally in all infected parts of the skin? Or in the clustered areas for instance use more pomade and in randomly scattered area use less?

Therefore, the basic aim is to investigate the spatial pattern of the skin diseases in depth with the aid of spatial data analysis and modeling techniques for any decision to be taken by the physicians/doctors for reducing the time of treatment and the amount of medicine to be used.

2- Problem definition:

As the science in every aspect is developed, the population of our planet is increased and trading, traveling, and immigrating are the main factors/elements of spreading disease from city to city, state to state, country to country, and definitely continent to continent.

We focus on point pattern on skin as it suits to spatial data analyses and visually it is exposed to the others and sick people are socio-evasive.

3- Data:

The first data is a photo of skin infected by fungus (figure 1). We marked the spots with red circle in order to transfer the photo to software with appropriate coordinate system to read the coordinates of spots to be put in the database.

We analyze the point pattern regardless of the type of disease, even if the initiative search leads us to the name and the type of fungus, which does not go deep in the skin.

4- Analyzing point pattern:

Visualization is the first step in any point pattern analyses, which is basically a dot map of the spatial phenomena. It provides developing appropriate hypothesis for the related point pattern. As can be seen from figure 2 the northern part of the study region, which is the body part close to neck indicates some clustered pattern.

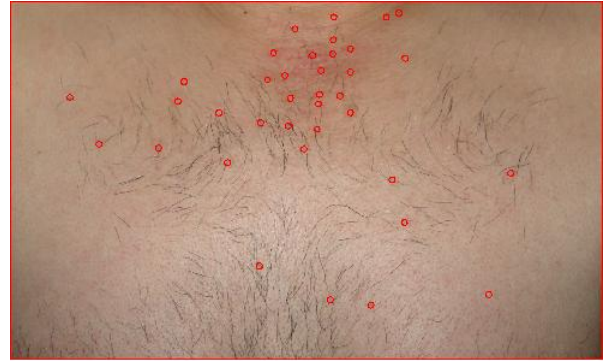


Figure 1, skin diseases, spotted pattern enhanced with red circles

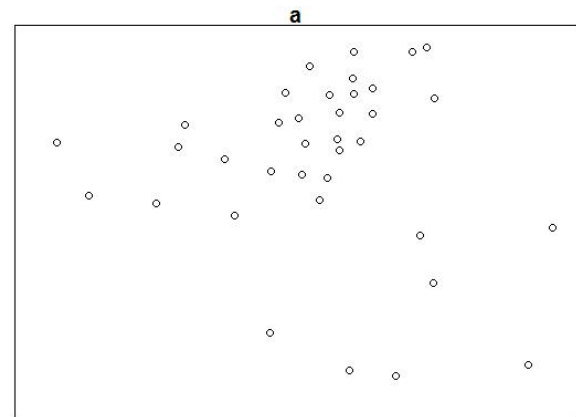


Figure 2, visualization of spotted pattern in R environment

5- Exploring the point pattern by density analyses:

The next step in spatial point pattern analyses is exploring the pattern's density. The simplest method of finding the density is quadrat analyses, where the study region is partitioned into quadrats and the number of points in each quadrat is mapped. As we see in figure 3 the densest quadrat has value 9 (9 spots) and the next dense quadrats are 6, 4, and 3. In figure 4 in down left, density is 0 (dark blue color) and as goes further to up, density increases which is enhanced with light yellow. Distribution of density in figure 4 is created based on the quadrat values in figure 3. What we perceive from this processing and analyzing is that intensity of spotted pattern on skin is in a place which is exposed to the pendant ingredients in the air, (see figure 1).

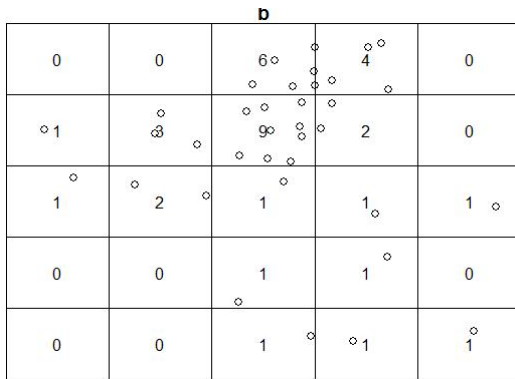


Figure 3, quadrat method, 5X5, in R

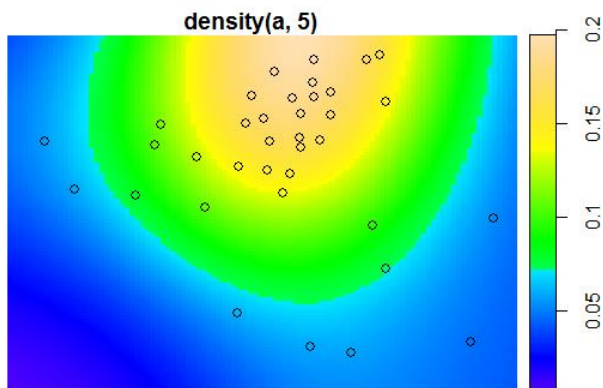


Figure 4, density of fungi (plural of fungus) on the infected skin

In figures 5 to 8 we see the described procedure in above to see the density in quadrats 3X3 and 2X2.

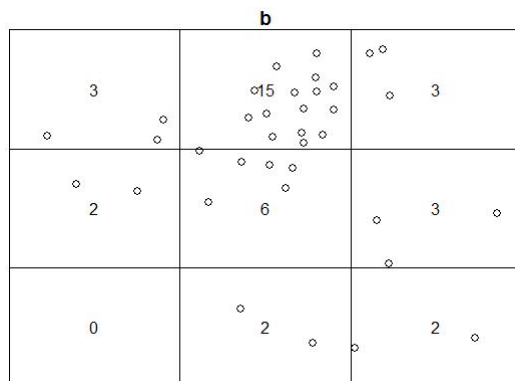


Figure 5, quadrat method, 3X3

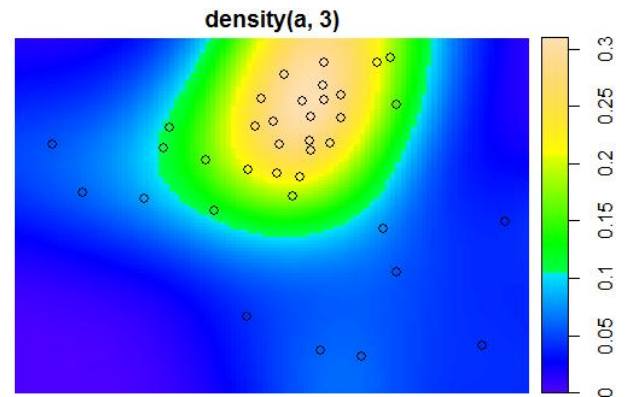


Figure 6, density of spotted pattern based on quadrat 3X3

As it is perceived from figures 3 to 8; the density of fungi are under the neck of the ill person and the more effected area is where is not covered with the cloths and is exposed to the pendant ingredients in the air and also enough light, moist, and fresh air.

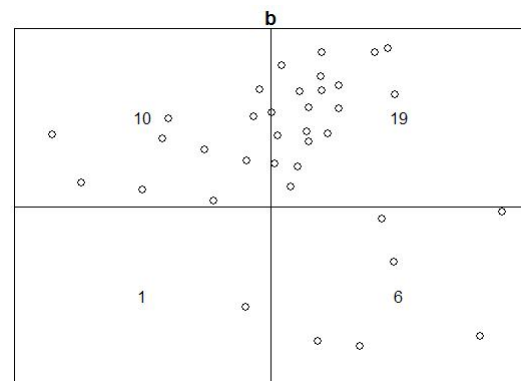


Figure 7, quadrat method, 2X2

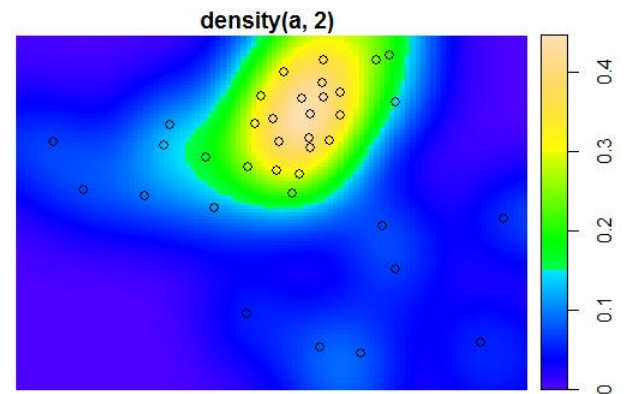


Figure 8, density of potted pattern based on quadrat 2X2

Another way of exploring the density of a point pattern is using Kernel estimation which gives a smoother estimate of density from the observed area (skin).

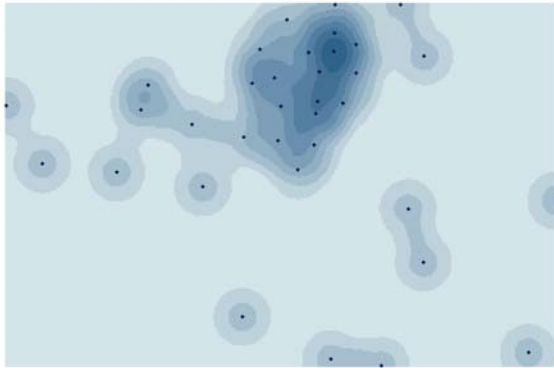


Figure 9, Kernel estimation, bandwidth 2 units and cell size 0.05 units

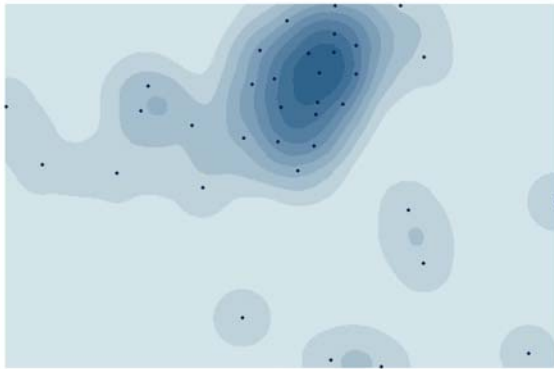


Figure 10, Kernel estimation, bandwidth 3 units and cell size 0.05 units

Figures 9, 10, and 11 are Kernel estimation for point pattern (fungus infections on the skin) with various bandwidths. Figures 9-11 suggest a cluster of spots near the neck area.

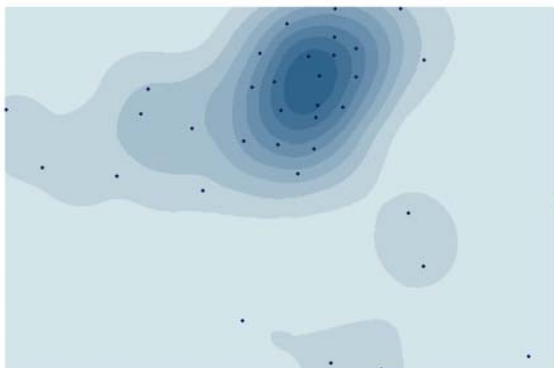


Figure 11, Kernel estimation, bandwidth 3 units and cell size 0.05 units

6- Testing the significance of the point pattern:

After exploring the point pattern, the next step is to statistically test the significance of the observed pattern.

The complete spatial randomness (CSR) forms the basis of a reference hypothesis, in which the observed pattern is tested against.

Hence CSR tests are implemented to see whether these red signs in figure 1 are clustered, regular or random. The K function and the transformed version of it called L function, is one of the tools for testing against CSR. The peaks of L function indicate clustering at the corresponding distances. The observed pattern is tested by comparing it with a random pattern created by simulations. The K and L functions for the observed pattern and the random realizations which are performed by simulations are illustrated in figures 12 and 13, respectively. In these figures, red and black curves are maximum and minimum simulated envelopes, respectively. The green curve is the estimated one. As the estimated envelope is most of the time above the simulated envelopes, especially for shorter distances, it can be said that fungi spots have a clustered pattern.

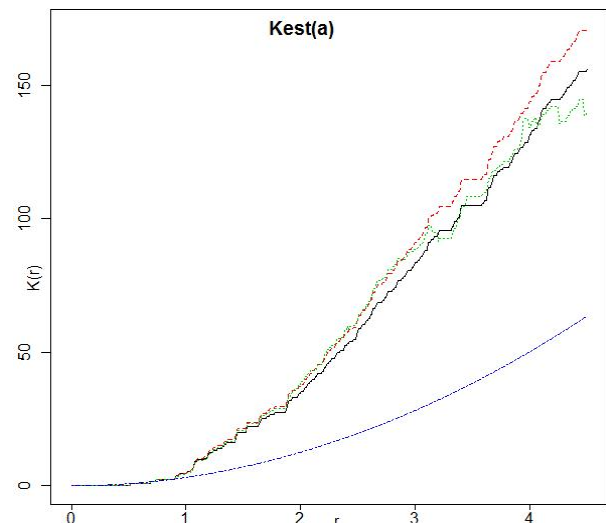


Figure 12, CSR test of K function shows clustering

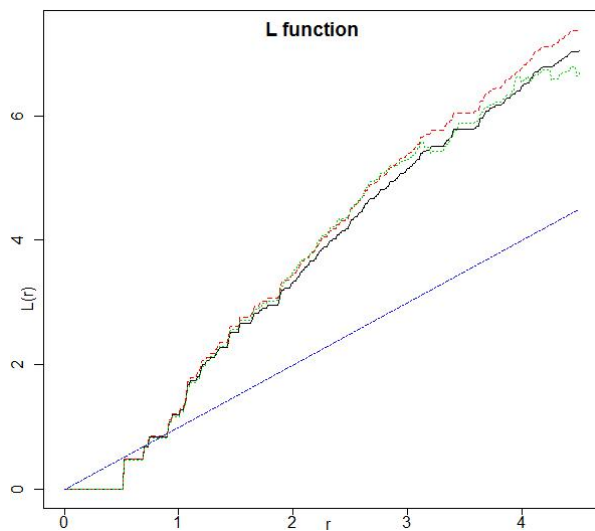


Figure 13, CSR test of L function indicates clustering

Now we go further to do more tests of point pattern distribution to get better idea of distribution of events.

According to the Figure 14, till distance 8, spotted pattern is clustered and figure 15 shows clustering to distance 7.

Here distances are discussed considering the photo scale in Figure 1.

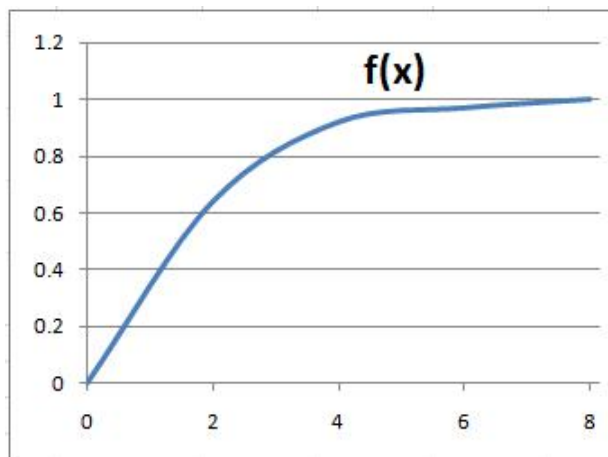


Figure 14, CSR test shows clustering

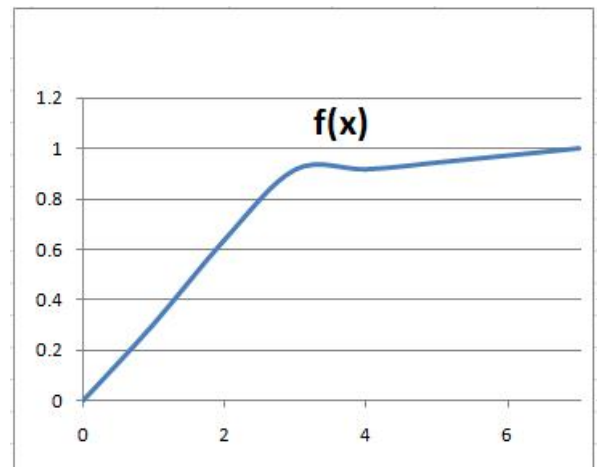


Figure 15, CSR test shows clustering

7- Conclusion:

Density analysis and CSR tests indicates clustering in the pattern of skin diseases. The most infected areas on the skin are exposed to the pendant ingredients and polluted air which normally is not covered by cloths.

Via E-Media it is possible to reduce the time of treatment and the amount of medicine to be used. The treatment can be done form distance in a reliable way (E-treatment).

8- References:

- 1- Baddeley, A., Turner, R., Spatial Point Pattern analysis, model-fitting, simulation, tests, the spatstat package, Version 1.14-9 December 17, 2008
- 2- Bailey, T. C., Gatrell, A. C., (1995), interactive spatial data analysis, Pearson Education Limited, Edinburgh Gate, Harlow, Eddex CM20 2JE, England
- 3- Düzgün, H.S.B., (2008) class's lecture notes, METU, Ankara, Turkey
- 4- Ribeiro Jr., P.J. & Diggle, P.J. (2001) geoR: A, package for geostatistical analysis. R-NEWS, Vol 1, No 2, 15-18. ISSN 1609-3631
- 4- Illian, J., Penttinen, A., Stoyan, H., Stoyan, D., (2008) Statistical Analysis and Modeling of Spatial Point Patterns, Jhan Wiley &Son, Ltd

PODCASTS – A WORLDWIDE STANDARD IN E-LEARNING

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Commission VI

KEY WORDS: Mobile devices, computer-assisted teaching, E-Learning, Podcasts, Web 2.0

EXTENDED ABSTRACT:

Internet technologies fascinate people of all age groups. The three buzzwords of everyday life are “always on, anywhere and anyplace”. Mobile devices become more and more powerful – they allow for learning-with-fun, creativity anytime at anyplace, and public understanding of complex issues. Within the next five years we will use mobile devices with built-in Inertial Navigation sensors and general GNSS receivers (compatible with GPS, Galileo, Glonass, and Baidou). Moreover, those devices will offer 1TB storage capacity on-board, HD photography and HD video recording, allow for communication speeds of up to 1 GBit/sec using LAN/WLAN/WiFi, and have in service additional sensors, such as temperature, air pressure, pedometer, to name just a few. The devices will easily communicate (wireless) with large HD displays, and are therefore excellent tools for students of all education systems.

Learning has become and will become more pleasant as it was before. One may argue about the consequences of this unlimited use of mobile devices. However, this discussion will not lead to any useful outcome. As a matter of fact, most people will use mobile devices instead of desktop and notebook computers, especially the young generation. There are public opinions about the size of content currently taught in primary, secondary and higher education – it seems that the content offered the last 20-30 years is much too less nowadays and in future. We have to double, or may be, even to triple the content! How will we perform this mammoth task? The answer seems to be simple: use the most recent technology with all its pleasant gadgets and apps.

When Apple introduced the first iPod generation (2002) nobody could foresee the story of success of this mobile device. Today, close to 200 Million devices have been sold – the iTunes (Music) Store offers digital media content of all kind: music (MP3 and other formats), audio podcasts, video podcasts, TV series, movies, and e-Learning content (through the iTunes U extension). Just recently, the iPhone 3rd generation has been announced, allowing for faster Internet access, HD photography, video capability, and other services. The app store offers more than 15.000 gadgets for download to make the iPhone or iPod Touch even more pleasant and powerful. The Apple TV allows for an easy link with the home theater TV, thus the iTunes Store comes to the couch when relaxing from a hard working day. Today, we find thousands of videos in the Apple podcast format (also in HD). Lesson learned: A computer manufacturer has become a world-wide leading institution for hardware, software and content!

Using the hype around iPod, iPhone and other mobile devices, learning content has to be offered in the same style and format as TV series, movies, YouTube videos, and others. Therefore, video podcasts (in short: *vodcasts*) seem to be a de facto standard already. Many Higher Education (High Ed) institutions offer today vodcasts for their students. Starting the Apple iTunes U extension in USA (2006) it swapped to Europe 2008 and is also available in Germany from Spring this year. This environment is Apple's answer to extend business and services to the 3L community. Unlike radio or streaming content via the Web, vodcasts are not real-time. Vodcast material is pre-recorded and the users can check out the material on-line and off-line. Certain vodcasts can even be live and interactive – dozens of podcasts enthusiasts can be on at once, with the host being able to control the audience in the same way a radio host can.

The Institute for Photogrammetry (ifp), Universitaet Stuttgart, started October 2006 to record teaching courses (and exercises) in Signal Processing, Geographical Information Systems, and Statistical Inference in vodcast formats. It was decided not to use a blackboard anymore, but a Tablet PC with a special recording SW to allow for annotations of complex issues (formulas, sketches, etc.) and vodcast creation right after the lecture. The lessons learned, by the students and the teacher, were very positive, and therefore it was decided (Feb. 2007) to offer all courses of ifp in vodcast formats. Besides the digital material for every special course new content is created. Therefore, we offer on the Web per lecture/exercise pdf notes (the TabletPC handwritten notes) and three different vodcast resolutions (QVGA 320x240, 480x320 and VGA 640x480). The students evaluate every course (lecture, exercise, lab work) by special assessment forms (towards the end of the term) just to indicate their expectation and satisfaction. On the other hand, the success of podcasting geospatial content of Universitaet Stuttgart has led to better prepared students in exams, what means, more complex questions are answered in a correct way. Moreover, off-campus and foreign students have access to the vodcasts as well and can see the ifp performance in research and teaching. In total, an overall assessment concludes with a very positive experience. In future, we will try to offer much more content in our lectures, exercises and lab work just to prove, whether it may be doubled or not.

The vision for the future is as follows: many vodcasts of all kind, especially for High Ed, are offered on the Web. The worldwide student community browses the Web and finds out the most brilliant vodcasts, according to their scientific content and pedagogical style. They rank these vodcasts just to give an indication about the quality and usability. Thus, it may happen easily, that preparations in GIS are made using database vodcasts of the Computer Science Dept. at MIT, visualization vodcasts of Univ. Stuttgart, analysis vodcasts of Tongji Univ. Shanghai, and data structure vodcasts of TU Berlin. Student learning in High Ed becomes really international! Highly ranked vodcasts hide some potential for future business models in Life Long Learning (3L), which will be developed parallel to the more and more increasing vodcast offer.

REFERENCES:

Balz, T., Fritsch, D. (2008): High-Performance SAR Simulation on Retail Video Gaming Consoles for Education and Training Purposes. Int. Arch. Photogrammetry & Remote Sensing (IAPRS), B6, pp. 213-219.

<http://www.ifp.uni-stuttgart.de/publications/downloads>

Fritsch, D. (2007): Podcasting Photogrammetry – A Contribution to Life-Long Learning. In: Photogrammetric Week '07, (Ed. D. Fritsch), Wichmann, Heidelberg, pp. 335-344

<http://www.ifp.uni-stuttgart.de/publications/downloads>

Murray, C., Sloan, J. (2007): iPodagogy – Using iPods and Video Podcasting for Learning. Report Dept. of Education, Victoria, Australia, 73 p.

Sharples, M. (2006): Portable and Mobile Educational Technology Research. University of Birmingham.

<http://www.becta.org.uk/>

VIRTUAL CAMPUS - PART OF THE ESRI TRAINING, EDUCATION, AND INFORMATION PROGRAM

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Commission VI, WG VI/1-2

KEY WORDS: training resources, GIS, Virtual Campus

ABSTRACT:

Since 1998, ESRI Virtual Campus has offered self-paced training over the Internet. Today, over 300.000 students from around the world get their GIS training on the Virtual Campus. ESRI Virtual Campus training is an affordable, high-quality learning experience using interactive exercises, examples, and instructional resources to create a rich learning environment. The convenience and ability to learn at your own pace in a dynamic educational environment are hallmarks of Virtual Campus training.

ESRI offers a variety of training and education products designed to meet the diverse training needs, learning styles, and budgets of our customers.

ESRI's Training Opportunities:

- Instructor-led courses are ideal for students who want to learn in a traditional classroom format where expert instruction, hands-on practice, class participation, and peer networking opportunities are emphasized.
- Instructor-led Virtual Classroom courses provide the benefits of instructor-led training in an interactive online class environment. Virtual Classroom courses have no associated travel costs, making them an affordable option for organizations that want access to an ESRI instructor.
- Web courses offer an excellent value to those who prefer to learn at their own pace.
- Online training seminars and Instructional Series podcasts are available at no cost and cover a wide variety of focused GIS technology topics.

Besides the “real” training opportunities, ESRI offers a variety of information sources such as:

- ESRI Support Center with user forums, whitepapers, knowledge bases, and tools for download
- ESRI Web help for nearly every ArcGIS Product with online tutorials
- ESRI Resource Centers – the ESRI gateway to information and services
- GIS Education Community
- Tutorials that come with ArcGIS Software – Short courses to get in touch with the software
- Training books – a broad variety of learning and information literature
- Newsletter, magazines and journals
- Podcasts, Blogs, Videos

INTRODUCTION OF RAPID E-LEARNING DEVELOPMENT WITHIN AN INTERNATIONAL GEOSPATIAL COMPANY

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KEY WORDS: E-Learning, Fugro, Geomatics

ABSTRACT:

E-learning offers many opportunities for training & development of staff within a large corporate environment such as consistency of message, flexibility of learning, availability of learning and monitoring of progress & performance. Rapid e-learning offers the same but with a promise of a quicker development cycle.

In this paper, we will discuss the way in which rapid e-learning can be of benefit in such an environment, both in terms of creating e-learning courses and of delivering them to the internal target audience.

The paper will address the use of desktop and web-based systems for course design and development, the development cycle and issues associated with distribution of the resulting materials.

The paper will present examples using the tools Fugro has selected when establishing The Fugro Academy in 2007.

1. INTRODUCTION

Rapid e-learning is currently popular within the (e-)learning community. The basic premise is that rapid e-learning can reduce the development time (and therefore cost) of creating e-learning courses from months down to weeks, perhaps even days.

This allows new e-learning course material to be distributed to those needing it much quicker than with traditional approaches.

It does this by providing authoring tools for non-IT experts to use, thereby putting the creation of e-learning content and courses into the hands of the subject matter experts.

Naturally, this is very appealing to organisations.

In this paper, we will look at the introduction of rapid authoring and e-learning into one organisation, Fugro.

2. WHY E-LEARNING

Why did Fugro look at e-learning?

Fugro is a large, global organisation conducting earth science investigations and consultancy both onshore and offshore around the world. The nature of this work is highly specialised and uses a number of core technical disciplines such as geophysics, geology, electronics and, of course, geomatics in its many forms.

The Fugro business operates on a highly decentralised basis, with daily operational and business decisions taking place primarily in the area where the local company is operating.

Having grown to over 13000 staff largely through a process of acquisition, there are many systems in place of different

heritages. This is particularly true with regard to software and procedural matters.

Over recent years there has been a desire and a need to standardise these systems and processes. This was initially implemented through class room training, but we can also see that e-learning can play a role in this, as systems change over time and so knowledge and skills need to be updated and maintained.

Many of our operations being field based; whether it is surveyors and geophysicists working on the high seas, electronics engineers and geologists working in remote airborne operations or geotechnical engineers and drillers working on remote site investigations.

Our staff therefore can spend long periods of time away from home and many seldom, if ever, actually work in a conventional office environment. This makes training and development a challenge when you rely upon regularly or scheduled classroom courses.

There is also an added factor that, having spent 4 weeks or more in the field and having accrued some well-earned rest and recuperation time, staff are reluctant to give up this valuable time for training.

Again, e-learning opens up opportunities to provide staff with development opportunities. From the comfort of home and without the need to travel or be away from home, staff can get updated on various technical and business-related developments.

Another factor in considering e-learning was also for staff currently in the field. In the offshore environment in particular, there are often periods when staff could develop skills, for example when there is weather downtime (i.e. the vessel cannot work because of high seas) or major breakdown (such as an

engine repair). At times like these, there are opportunities for learning, but of course they are unplanned and so getting a trainer on site or providing the training environment is logistically difficult. It would be ideal if the learning material was onboard, or available on-demand, when the learner had available time.

3. PRIOR E-LEARNING EXPERIENCE

Fugro's introduction to e-learning in 2007 was not our first e-learning venture. As early as 2001, we had identified the potential that e-learning had to assist in developing staff skills whilst working remotely.

An early exploration into e-learning had used an HTML Help Authoring package, RoboHelp, for creating e-learning material. Although the results produced were acceptable, it was found that development of the courses presented a number of issues including

- Managing source material with a desktop application
- Reviewing courses with multiple authors or reviewers
- Maintaining navigation between pages when restructuring courses
- Avoiding the look and feel of a Help file
- Limited interactivity and multimedia capability
- Protecting course content

Trials with several e-learning or course authoring packages identified the steep learning curve, the understanding of complex software, and even programming skills, that would be needed. In addition, it seemed likely that a dedicated specialist team would be required to develop courses with these products.

The various trials undertaken between 2001 and 2005 provided some lessons that we would apply in the future selection of an authoring package

These included:-

- Choosing the right tool for the job. Trying to use a tool designed for another purpose does not necessarily provide the best results
- Sophisticated e-learning may need complex tools to create it. These tools in turn may have significant learning needs in themselves and even specialist staff to operate them, with long development timescales
- Tools should be easy to use. It was not, and still is not, our intention to have a dedicated e-learning team. Our vision is to use the skills and knowledge of our existing trainers and subject matter experts to produce the majority of our e-learning, which means they need to quickly grasp the use of the authoring tool.

4. RAPID AUTHORING

Why adopt a Rapid Authoring approach?

Having established The Fugro Academy in 2007 and identified that e-learning was of use to Fugro and could provide opportunities for staff training and development that were currently lacking, attention turned to the tools to be used.

We'd become aware of rapid authoring tools a few years earlier and so had some appreciation of the benefits they offered.

Given the dynamic nature of our business and the need to push a wide range of new information out to a global workforce, any approach that could reduce time and be simple to use had an appeal.

We also recognised that much of our specialised knowledge was in the hands (or minds) of various technical experts (subject matter experts in e-learning terminology). By getting these people to create courses, we could capture and disseminate that experience to a wider community very easily.

Rapid authoring seems to offer everything you'd every want:-

- Fast development and creation of courses
- Short learning curve for users
- Simple and short training requirements
- Only a basic level of IT knowledge needed
- Acceptable (even good, arguably excellent) quality of products

We signed up!

5. SELECTION OF TOOLS

But first, we evaluated a number of different packages from the rapid authoring stable of products. As with any software selection, the range of options was overwhelming and, at times, difficult to separate the 'need to have' from the 'nice to have'

The selection of an appropriate authoring tool (or tools) depended upon several criteria. Some of the main ones were:-

- Easy to use
- Easy to install or access
- Easy to backup course material
- Content and output should be in a secure and ideally non-copyable format
- A variety of output formats should be supported

Initially we hadn't considered the deployment method too much; either desktop or web-based. At that time, we were experienced in the use of desktop software, but had little experience in web-based application software.

However, after seeing a few products that operated on this basis, we began to appreciate the benefits of such a deployment for the enterprise-wide approach Fugro was taking, so narrowed our selection down to web-based products.

The product we selected as our core authoring tool was Mohive's e-Learning Publishing System or eLPS. In the next section, we'll discuss some of the reasons for this.

We also selected Adobe's Captivate (previously called RoboDemo, a sister product to RoboHelp) for software simulation recording. This will also be discussed later.

6. MOHIVE ELPS

Mohive eLPS is a web-based enterprise-wide collaborative rapid authoring and publishing system.

There were a number of reasons why we selected it.

Mohive has a logical, integrated workflow model that makes it easy for an author to develop their e-learning course. The process goes from planning the e-learning module, to authoring

the content, to quality control and review activities and finally to publishing. It can publish to SCORM, EXE, SWF and PDF, providing a high degree of flexibility for delivery of e-learning course products.

Mohive operates on a template-based authoring approach. It has a wide range of standard templates that the author populates with the relevant details and then previews to see the learner's view of it. Templates provide various types of interactions, multimedia displays and quiz/assessment tools. This makes it easy for authors to use, as generally no screen layout planning is necessary and consistency is achieved.

The collaborative nature was known of when we selected Mohive but the power of this was not fully appreciated until we started to use the system for development. We knew we wanted our various specialists to work together on courses but the online nature of the package makes subject matter experts and quality review very simple to conduct. Course material authored in the morning can be reviewed and commented by personnel around the world within the same day. The review process can even extend into the field or offshore as long as a reasonable internet connection is available.

Linked to the collaboration, the quality control facilities are probably the main functional elements that differentiated the Mohive product from the others we evaluated. Working in the oil and gas industry, quality control and quality assurance requirements are common place and being able to introduce this easily to our e-learning development process is a great advantage. With Mohive, the author can initiate a review cycle and monitor the various reviewers as they comment on the course. At the end of the review cycle, the author can then action the comments, leaving an audit trail of corrections and amendments. Subsequent review cycles can then include management for approval and adherence to corporate guidelines.

7. COURSE DEVELOPMENT PROCESS

Although the Mohive workflow is a great benefit and makes the e-learning development process much simpler, we have realised that it is not enough in itself and needs supplemented.

Rapid e-learning development relies not just on rapid authoring tools but also on other processes being carried out quicker than traditional systems development. By cutting down the timescales on each phase, the overall timescale gets compressed.

Nevertheless, some of the traditional approaches like ADDIE (Analysis, Design, Development, Implementation, Evaluation) can be modified and applied.

This is the approach we are currently working on to put some structure to the process and add to the quality assurance of the products we create. This is a recent implementation and too early to say if it's the correct or optimum approach.

It has also been recognised that various standards and guidelines are also required if you want to maintain some consistency in style and appearance.

Initial, we thought the template based approach in Mohive was adequate. However once multiple users got involved, it became

clear that this was not the case and more formal documentation guidelines were needed.

In addition, as other media was incorporated such as Captivate files, the need for this increased.

Variation style guides and standards are now under development.

8. ADOBE CAPTIVATE

Adobe Captivate is the other component in our rapid authoring armoury.

Captivate, previously known as RoboDemo, was initially developed by the same company who created RoboHelp where our e-learning journey began.

Captivate is a desktop rapid authoring application that allows recording and playback of software demonstrations and simulations, as well being as a full authoring application in its own right.

In common with Mohive, Captivate can publish to SCORM, EXE, SWF and PDF providing similar flexibility in distribution of the e-learning products.

As internally-developed software applications are where a significant amount of classroom training effort is spent, Captivate provides the ability to take this and move it into the e-learning environment. Recording a simulation or demonstration takes no longer than performing the software function you are demonstrating. Annotating and enhancing this for e-learning delivery adds an overhead on top of this, but the process remains quick and is of course deliverable to a much wider audience on demand.

The SWF output from Captivate can be embedded into Mohive so that the demonstrations or simulations can be integrated into a wider context.

One of the main benefits of Captivate simulation capability is that you don't actually need to have the application software installed on the learner's PC. This overcomes issues with software licensing, operating systems, configuration and versioning issues, all factors that can plague classroom delivered training courses.

The Captivate simulation can guide the learner through use of a new piece of software and make them familiar with it before they get exposed to it for real. It can also be used for competence assessment purposes.

9. E-LEARNING DISTRIBUTION

Creation of your e-learning course is one thing. Getting it to your learners is another and some problems do exist in this area for us.

In our infrastructure build-up, we also selected and implemented a Learning Management System, Enterprise Knowledge Platform (EKP) from NetDimensions. The architecture and configuration of EKP allow us to closely match in the virtual world, the Fugro organisation that exists in the real world.

With limited central resources to manage an enterprise solution like this, local administrators were trained to manage local operations and staff. At a corporate level, a small team manage the system and provide support.

The principle is simple, through internet delivery, staff anywhere in the world can login, view the courses available and sign up for them. If the course was an e-learning one they could also take it. For many of our users, this is exactly what happens.

But introduce ships and aeroplanes, and people working remotely, and most especially limited internet bandwidth and problems develop. Although many of our vessels now have internet connections, the bandwidth is too low to stream or download media-rich material. On client vessels, our internet access may also be restricted. Even on high bandwidth vessels, much of the bandwidth is used for business and communications traffic.

So we had to look for another solution for this group. This is the introduction of a mobile version of EKP. In principle, a learner with a laptop can log on to the system and, knowing that they will be without a connection for a period of time, sign up and download a series of courses to take offline. Upon returning to the modern world with internet access, they would log on again and the system would synchronise and update itself to reflect the learning and assessments they had completed whilst away. As this feature is still under development, we also needed to look at another solution

Our third option is downloading courses to CD, DVD or USB and giving them to the staff physically. This is where the flexibility of Mohive and Captivate for publishing comes in. We can still author in our chosen environment, we simply publish to EXE or SWF as well as to SCORM. Unfortunately, we lose the detailed tracking information SCORM provides, but more importantly, learning and development can take place. Although not the optimum solution, we anticipate that this will be a temporary solution until the mobile version is available or wider bandwidth is possible.

10. ONGOING ISSUES

Fugro is still early on in its journey into e-learning. Consequently, we are still defining and refining processes as we gain experience in many areas. We have a number of ongoing issues to address.

Distribution is one that has already been mentioned.

The development process is another. This is being tested currently through a series of pilot projects. As we run these pilots, we can look at the process we are using and evaluate whether it is correct or not. Already it has highlighted that we need documented processes, standards and guidelines to ensure consistency in products. Other improvements may also be identified.

Development timescales are at this stage largely unknown. We know it can be rapid; we've produced courses in less than half a day and pushed them out to a global audience on the same day. But as courses get more complex, the time taken extends. The development processes we develop will also impact on timescales. We don't want to burden the system down in process, but at the same time we do need a model to follow.

Some more experience is needed to allow us to estimate the effort needed, so we can plan assignments and delivery schedules better

Probably the biggest challenge is the area of instructional design. Most, if not all, of our course designers and authors have no formal instruction design training or education. Processes and approaches used for classroom training don't necessarily apply for e-learning. There's also a skill in deciding what makes an e-learning course engaging for a learner. Effectively, what does a good e-learning course look like?

11. SUMMARY

Although still at an early stage, the introduction of rapid authoring and e-learning into Fugro has so far been successful. The concept has lived up to its claims and a number of courses have been created and distributed quickly and easily to a worldwide audience.

The process is not as simple as initially thought though, and some effort is currently taking place to develop a development process and accompanying documentation such as procedures, guidelines and standards. Although introduction of such systems will inevitably slow down the process to an extent, in a corporate environment such measures are necessary to ensure consistency and quality of products. As authors and others involved in the process gain experience, this overhead may reduce.

Instructional design is another area where some additional experience is needed. Evidence from several authors shows that course quality improves over time as the author gains experience in creating e-learning, but remains a potential problem area when tools are put into the hands of subject matter experts with little or no training experience.

COMBINING SYNCHRONOUS AND ASYNCHRONOUS ELEARNING TOOLS IN DISTANCE EDUCATION – EXPERIENCES FROM A COURSE FOR DEVELOPING COUNTRIES

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Commissions VI/1 - VI/2

KEY WORDS: distance learning, synchronous learning, asynchronous learning, Elluminate, developing countries, spatial decision support system, distance education

ABSTRACT:

Distance learning requires a specific effort of addressing the students: Students motivation has to be kept up high throughout the course via interesting and diversified teaching material and methods. Experiences from distance courses held in asynchronous teaching mode showed that this is difficult over a longer period. Adding live online interaction using a virtual classroom system for synchronous teaching generated positive effects in terms of student's motivation and engagement. An already established eight weeks distance course using Blackboard learning system has been brushed up with live online interaction using Elluminate *Live!*, a real-time virtual classroom that allows live interactions. Scheduled at strategic moments throughout the course, these live sessions help to cover important topics in detail and to keep the motivation of the students high throughout the course. The share of drop outs during the course was considerably decreased compared to previous courses. Technical problems related to synchronous approach with developing countries in terms of limited internet access or low bandwidth could be alleviated by modifying the pedagogical approach implemented.

1. INTRODUCTION

Distance learning always requires a specific form and effort of addressing the students. In absence of a teacher motivating through face to face contact motivation of the students has to be kept up high throughout the course for instance through self-activating teaching and diversified learning material and methods. A major key to motivated distance learning lies in enabling continuous interactions between students and lecturers/instructors as well as among students. Various "studies indicate that interactions between students and instructors as well as student-to-student interactions enhance education at a distance by improving attitudes, encouraging earlier completion of coursework, improving performance on tests, allowing deep and meaningful learning opportunities, increasing retention rates, and building learning communities" (Schullo et al. 2007).

The aim of the paper is to report about an eight weeks distance course for students in developing countries based on asynchronous teaching using the Blackboard learning environment. This asynchronous distance course has been brushed up with live online sessions in synchronous teaching mode using the virtual classroom system Elluminate *Live!*. After some introductory reflections on benefits and downsides of synchronous and asynchronous distance teaching the structure and concept of the relevant ITC distance course "Spatial Decision Support Systems" is explained. In the following section the Elluminate *Live!* virtual classroom system is introduced briefly in its main functionalities. The live sessions, added to the existing course, are described and evaluated based on both students performance and their feedback. Finally some conclusions are drawn regarding the combination of synchronous and asynchronous eLearning methods and tools for a successful distance education and regarding the suitability of

the Elluminate *Live!* to be used in such a "blended" distance learning setting.

2. SYNCHRONOUS AND ASYNCHRONOUS DISTANCE LEARNING

Since the advent of the World Wide Web distance learning in higher education has become more and more popular. In 2005 "about 88 percent of 2-year and 86 percent of 4-year public postsecondary institutions offered distance education courses" (Schullo et al. 2007). According to Rovai et al. (2008) "distance education delivered mostly asynchronously via the internet using internet based learning management systems is the most popular distance learning mode used in higher education today."

The advantages of asynchronous learning in distance education are obvious. Students are increasingly autonomous in terms of time management, i.e. they are more or less free to choose when to do the lessons and exercises each day and whether to start with the course early in the beginning or at a later stage. This is especially an important argument when students live in different time zones, e.g. in developing countries. Furthermore this flexibility also allows reconciling professional, educational, and other duties e.g. taking care for a family while working and still doing vocational training.

Asynchronous distance education also allows students to study at their own pace; those who are faster in learning can go quickly through the material while others who like to repeat certain issues or generally prefer to proceed at a slower pace through a lecture are also served. Asynchronous teaching mode also works as a leveller in terms of participation, i.e. everyone is able to contribute to the course, where in real class room

situation those who tend to talk much could be sometimes dominating the course. Again this is especially relevant when working in a multicultural environment with students from developing countries as their language capabilities are often unequally developed resp. differences in cultural behaviour influence a determine a more or less active participation. Finally asynchronous distance courses are technically not so demanding, e.g. in terms of quality of the internet access and bandwidth, and a large number of students can be served in one course, even though input in time and resources on the instructors side, e.g. for commenting on individual exercises, can increase quite immensely.

The major downside of giving distance courses in a purely asynchronous mode is that it is quite difficult to maintain motivation of the students throughout the course, especially in longer course for about a few weeks. While the motivation to follow the distance course is usually high in the beginning some decrease can be observed over the weeks and in the end usually not all who have started finish the course. This usually goes along with problems of keeping the specified time schedule of the course. To provide an utmost flexibility for the students, hardly any deadlines are given except for allocated exams, which in combination with a decreasing motivation could lead to time problems in the end, sometimes even up to request to extend the duration of the course. Another disadvantage of asynchronous courses, regularly mentioned in course evaluations is that students sometimes miss a straight feedback by the lecturers on exercises or problems. Last but not least, as mentioned above already, teaching asynchronous distance courses, even when they are fully developed, are everything else but timesaving for the instructor.

Synchronous distance learning on the other hand, where students and instructors/lecturers meet virtually in the web, has become very popular in the last years enabled mainly by the almost ubiquitous accessibility to broadband internet connection nowadays. It allows lively interactions, which can create a social atmosphere among students and instructors. The participants can have informal text chatting, as well as audio and video conversations. This type of informal interactions, builds a virtual community, which increases students' motivation in a distance learning process. Furthermore learning can be much more instructed be lecturers when teaching in synchronous mode and students can get immediate feedback. Another benefit of synchronous learning is that external experts can be invited, even on a quite ad hoc basis, to join single sessions on specific topics.

Negative aspects to be named for synchronous learning lie mainly in logistics and time constraints: Participants all have to be online at the same time, and sessions hardly can last longer than 60 to 90 minutes (Clark 2005). Being online at the same time can be especially difficult when learning in multicultural context with students living and studying in different time zones. Furthermore technical aspects in terms of internet access and speed could be a bottleneck for students in developing countries, as synchronous eLearning tools (video, voice stream, etc.) usually require excellent internet quality which is not yet given everywhere.

An self-evident solution lies in taking the best of both worlds, i.e. combining synchronous and asynchronous learning tools in distance education courses (Rovai et al. 2008). Lister et al. (1999) sketch the Rensselaer 80/20 Model as a kind of conceptual framework for this. "About 80 % of a student's time

would be spent on self-paced engagement of online materials and about 20% in interactive, synchronous learning sessions with the instructor and other students (Lister et al. 1999). Schulmeister (2006) describes the alteration between synchronous events, where students for instance discuss and develop ideas together, and subsequent asynchronous phases, in which the students further develop and elaborate the ideas, as a very prolific learning environment. In the following section a tool for synchronous distance teaching is briefly described in its main functionalities.

3. ELLUMINATE LIVE! VIRTUAL CLASSROOM

Elluminate *Live!* (<http://www.elluminate.com/>) is a virtual classroom system for synchronous distance learning that allows live interactions between students and lecturers resp. instructors. Main components of Elluminate *Live!* that facilitate interactions are a whiteboard tool, a chat tool, and an audio tool (see figure 1). Next to this the participants window (figure 1, 2) enables students to engage in the session and to give feedback. It also allows instructors to monitor student's activities and the quality of their internet access. An optional video tool supporting multiple video feeds for up to six participants can be activated if required.



Figure 1. Elluminate Live! interface

More key features of Elluminate Live! are application sharing, handing over of desktop control, interactive whiteboard, PowerPoint import, polling, indexed recording and playback, and working in break out rooms (see Elluminate Inc. 2007). Two roles are assigned during an Elluminate session: The moderator who directs the session is in full control of all functions of Elluminate. Participants follow the session and can interact with other participants in various ways described below. The moderator can grant moderator privileges to other participants. They gain then same control over all available functionalities as the instructor (Pei 2009).

An advantage of the tool for teaching in developing countries is that Elluminate requires a relatively low bandwidth. If the internet speed is low at a certain moment the system buffers the audio and plays it later again at a slightly higher speed (Elluminate Inc. 2007). To join an Elluminate session a Java application (Java web Start) needs to be downloaded. The whole process to initiate or to join an Elluminate session takes about 15 minutes without any prior registration. Furthermore the systems allows to record full sessions which can be downloaded from the Elluminate server and watched if required.

The most important benefit of synchronous learning is the opportunity to enable a high level of interaction between students and instructors as well as among students and to keep students engaged in the teaching process. Elluminate *Live!* provides various functions to support this, which are controlled and visible via the participants window (see figure 2): During the session students can virtually raise hands for questions which is heard and seen by the instructor who can stop teaching and let the students ask a question. In order to quickly respond during the session, e.g. to clarify whether a certain topic is clearly understood, four different emoticons can be selected by the students for giving feedback. The students can express agreement or disagreement (applause or thumbs down icon) and can choose between a smiley (☺) and a frowney (☹), depending whether they are fine with something or not (e.g. have finished a task or not yet.) Finally polls can be organized by the instructor for fast feedback, e.g. assess the quality of this lecture on a five scale rank.

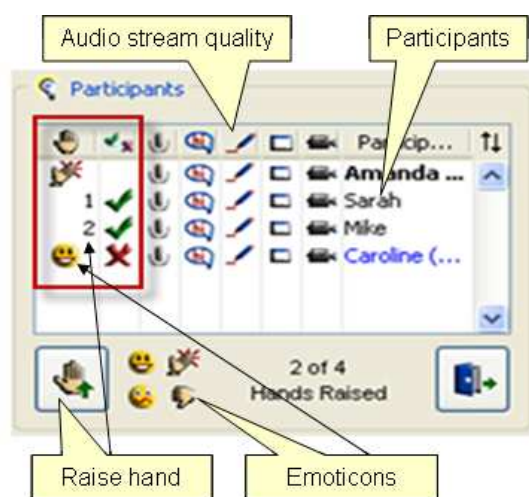


Figure 2. Elluminate *Live!* Participants window

The Elluminate *Live!* virtual classroom has become popular since a few years and is used by several different US-American universities. In 2008 also the Open University UK (OU, <http://www.open.ac.uk/>) one of the pioneers in Europe in large scale distance learning, has chosen Elluminate *Live!* as their enterprise synchronous collaboration (Schlusman et al. 2008). Schullo et al (2007) analyzed that Elluminate *Live!* meets quite well the pedagogic needs of instructors and trainers involved in distance education.

4. DISTANCE EDUCATION AT ITC

The International Institute for Geo-Information Science and Earth Observation (ITC) is developing and implementing distance courses in the field of geo-information science and earth observation since 2005. Nowadays ten different courses are offered, covering topics like Principles of Geographical Information Systems, Geostatistics and Open-Source Statistical Computing, Sustainable Agriculture or Environmental Impact Assessment and Strategic Environmental Assessment (<http://www.itc.nl/education/programmes/default.aspx>). All courses last for six to eight weeks and have a workload of approx. 20 hours per week. Each course is held once a year usually for a group of 10 to 25 students from various developing countries.

The general approach in all ITC distance courses is task-based learning that blends theory and practice. The courses combine self study with online support by ITC staff. All distance courses are conducted as asynchronous distance courses using Blackboard Learning System, through which material (video- and e-lectures, exercises) is provided for students. The communication between students and lecturers as well as among students usually is organized predominantly via Blackboard discussion forums and sometimes email. Synchronous forms of communication and interaction between students and instructors are included relatively limited so far using Instant Messaging (chat) and VoIP communication such as Skype, etc.

4.1 The distance course Spatial Decision Support Systems

The ITC distance course Spatial Decision Support Systems (DE SDSS) introduces participants to techniques for selecting and processing data to improve decision making in various sectors of spatial planning. The necessary tools, techniques, models and decision-making procedures can be integrated in a user-friendly information processing system called a spatial decision support system (SDSS). Participants in the course learn how to structure and implement decision making processes as well as how to facilitate these using SDSS.

The eight weeks course is structured into six lessons of different length (figure 3). While the first three lessons cover mainly theoretical frameworks and concepts of spatial decision making, the lessons 4 to 6 focus on practical applications of SDSS in form of hands on exercises and case studies. Each lesson consists of various e-lectures in form of recorded PowerPoint slide shows annotated with streaming audio, selected papers as pdf-documents, and exercises the students have to work on.

The course is conducted since three years now. Each year the course was taken by 10 to 15 students, who were located in various African countries (Tanzania, Namibia, Egypt, Ghana) in Latin America (Brazil, Guatemala, Colombia) and in Asia (India, Nepal), as well as occasionally in some European countries (Greece, Sweden). The students receive a CD-Rom with all the course material, which they could access through Blackboard, prior to the course start. Communication and interaction is organized through discussion forums in Blackboard. Students have to upload their contributions (exercises) here and receive comments from the lecturers involved. Students as well are requested to comment on contributions of their fellow students. But this only happens occasionally, primarily because they hardly worked parallel on the same exercises.

The evaluation of the distance course by the students was predominantly positive in each year. Students appreciated the content of the course as well as the way the course was delivered. Further positive aspects mentioned were that the students were in control of the learning process and students had intensive discussions with the lecturers (Boerboom and Groenendijk 2007). Negative aspects mentioned in the regular evaluation were mainly technical (Blackboard, internet access) as well as resource problems (not enough time to finish the exercises) but also issues like a lack of communication or scarce feedback from fellow students.

Further problems in the course evolved out of the fact that the students worked at their own pace. This led to a situation where some students were still stuck in lesson 2 while others already worked on lesson 5. This can partly explain the limited

interaction between students, because students who are already busy with another lesson usually don't reply to upload of slower students. On the other hand the front-runners didn't receive comments on their contributions either, because the other students neither had the proper understanding already nor the time to respond in a qualified manner. Finally some students didn't allocate sufficient time to work on the material properly, but only increased their input shortly before the exams, which led to a low quality of their contributions.

In the long run the distance course revealed some of the typical problems that go along with asynchronous distance teaching over a longer period (see above, cf. Rovai et al. 2008): All students were highly motivated to work on the course material and to interact with each other in the beginning, but the motivation gradually decreased during the course. Consequently in each year a certain number of students did not finish the course, but dropped out before, either quite early after two or three weeks or during the second half of the course. Even though only a detailed ex post evaluation could reveal motives for drop outs from the course, a relationship with decreasing motivation cannot be dismissed.

4.2 DE SDSS 2008 with Elluminate *Live!*

The DE SDSS course, held for the third time in October to December 2008, had nine participants from Egypt, Tanzania, Kenya, Rwanda, Brazil, Guatemala, Jamaica, Colombia, and Sweden. To improve the interaction between students and instructors and thereby the performance of students in the course synchronous learning sessions were added to the course as described above using Elluminate *Live!* virtual classroom.

In total three sessions were scheduled strategically throughout the course (figure 3):

1. One week after the course starts to get in touch with the students, to see whether problems have occurred during the start phase and to introduce the students to Elluminate *Live!*. The session was also used to discuss a short text students had to produce and upload at the end of lesson 1.
2. During lesson 5, in which important concepts of spatial decision support were practiced by the students in two comprehensive exercises. The session was organized as a question & answer session.
3. Two days before the final exam to tackle open questions and to discuss problems students ran into while preparing for the exam. The session was also an open question and answer session.

Each session was scheduled for one hour duration. In the beginning of the first session participants were introduced to basic functions of Elluminate *Live!* for about 15 minutes. In the session 2 and 3 this introduction was repeated within 5 minutes. After the introduction the students were sufficiently enabled to participate and interact in the sessions. They used mainly the chat and audio tools as well as functions to engage in the learning process (raise hand, emoticons). For discussing the text in session one the application sharing functionality was used for collaboratively working in a word document. All sessions were conducted with two lecturers.

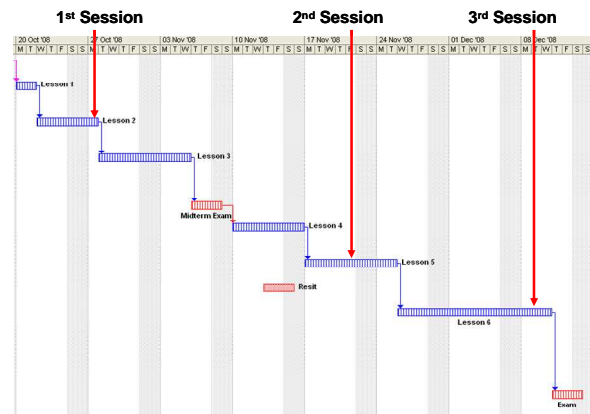


Figure 3. Scheduling of Elluminate *Live!* sessions

For the question and answers blocks in sessions 2 and 3 questions from the students were collected in the beginning of the session using chat and whiteboard tools as well as prior to the session via email. This procedure was implemented because during the first session the audio stream from some student's location (especially in Africa) was sometimes heavily discontinuous due to interrupted internet access. In contrary the answers to the questions from the instructors (Netherlands) transmitted via audio stream was understood in all places quite well.

The participants easily understood how to use basic functions of Elluminate *Live!* and quickly adopted the various forms of engagement and interaction like hand raising, writing chat or using the emoticons to express agreement or disagreement (Pei and Flacke 2009). During this login phase students already started using chat tool to communicate and socialize with each other. Recorded sessions were used by students who missed a session or wanted to prepare for the final exam.

The evaluation of the combined distance course showed that the motivation to follow the course could have been kept almost constantly high throughout the course. Especially shortly after the single live sessions students were stimulated to work for the course. The share of drop outs during the course was considerably decreased compared to previous courses.

5. CONCLUSIONS

Collis (1996) outlined four equally compelling advantages of synchronous distance learning in an instructional context.

- "Motivation - synchronous systems provide motivation for distance learners to keep up with their peers.
- Telepresence - real time interaction fosters development of group cohesion and a sense of community.
- Good feedback - synchronous systems provide quick feedback and support consensus and decision-making in group activities.
- Pacing - synchronous events encourage a discipline in learning, helping students to prioritize their studies." (Collis 1996).

Looking at the experiences made with the DE SDSS course in 2008 in which synchronous learning events were added to an existing asynchronous course all aspects mentioned by Collis can be confirmed. Regarding **motivation** it is quite obvious that

the engagement of the students could have been kept more constant throughout the course, compared to previous years. This observation is substantiated by a lower drop out quote from the course.

Also a **sense of community** was created among the distance course students. Students started to reply to each other during the live sessions and used the chat tool to discuss different topics prior to the start of the sessions when already logged in. During the 2nd live session it was agreed among the students that everybody would notify in Blackboard on which of the case studies in lessons 6 he or she plans to work (4 different case studies were offered) in order to enable an exchange during the case study work.

The opportunity to provide **good feedback** in synchronous mode was in particular used during the question & answer sessions. For instance problems raised by students regarding the final exam could have been resolved instantaneously. Finally also **pacing** of students was improved to a certain degree. Most of the students tried to finish lectures and exercise ahead of the scheduled live sessions.

Concluding it is to adhere that through the inclusion of synchronous learning sessions to an existing asynchronous distance course an added value could have been created; bearing in mind the postulation that “good” elearning is supposed to provide an added certain value to face to face (cf. Glowalla 2005, Schulmeister 2006). Furthermore the tools included in Elluminate *Live!* virtual classroom offer suitable possibilities to implemented synchronous sessions easily and thereby can increase the benefit of distance courses.

When designing and implementing synchronous events the following issues should be considered:

- Schedule the live sessions strategically in the existing course agenda to make full use of its advantages.
- Elluminate sessions should preferably be held best with two lecturers resp. instructors, e.g. one teaching while the other one at the same time is tasking care of chat and other devises.
- Make sure that all students have a reasonable internet connection, when scheduling the sessions.

Finally it is to be mentioned that the Elluminate *Live!* tool can potentially be used not only for teaching, but also for remote MSc or PhD supervision or for virtual project meetings. Problems in distance MSc supervision as described in Groenendijk (2007) could thereby alleviated.

The development of multi-user courseware, which is courseware that can be used in different teaching modalities like face to learning, distance and education (ten Dam 2006), can also be supported by using Elluminate *Live!*. For instance when index recorded Elluminate lectures are used as self studying material by students in an original class room situation.

6. REFERENCES

- Boerboom, L., Groenendijk, L., 2007. Can we benefit at ITC from distance learning? *ITC News* (1), pp. 8–9.
- Clark, R.C., 2005. Harnessing the virtual classroom. *TD* (November), pp. 41–43.
- Collis, B., 1996. *Tele-learning in a digital world: The future of distance learning*.: International Thomson Publications, London.
- Elluminate Inc., 2007. Elluminate *Live!* moderator's guide - version 8.
- Glowalla, U., 2005. Erfolgversprechende Einsatzszenarien für Mehrwert stiftende E-Learning Anwendungen. *GIS-Geo-Informationssysteme* (6) pp. 20-25.
- Groenendijk, L., 2007. E-Supervision: Experiences with MSc Supervision on a Distance using Online communication tools. In: *eLearning Africa. 2nd International Conference on ICT for Development, Education and Training*, 28-30 May, 2007 Nairobi : book of abstracts. Berlin : ICWE GmbH, 2007. pp. 253-257.
- Lister, B., Danchak, M., Scalzo, K., Jennings, W., Wilson, J. 1999. The Rensselaer 80/20 Model for Interactive Distance Learning. In *EDUCAUSE '99 conference online proceedings* October 26–29, 1999, Long Beach, CA.
- Pei, L., 2009. Conducting Elluminate sessions – Manual for ITC staff. Enschede, The Netherlands.
- Pei, L., Flacke, J., 2009. Real-time online learning: An Elluminate virtual classroom. *ITC News* (1), pp. 8-9.
- Rovai, A. P., Ponton, M. K., Baker, J. D., 2008. *Distance learning in higher education: A programmatic approach to planning, design, instruction, evaluation, and accreditation*. Teachers College Press, New York.
- Schlusman, K., Giesbertz, W., Rusman, E., 2008. Ervaringen met een virtuele Klas. *Onderwijsinnovatie* (December), pp. 29–31.
- Schullo, S., Hilbelink, A., Venable, M., Barron, A., 2007. Selecting a Virtual Classroom System: Elluminate Live vs. Macromedia Breeze (Adobe Acrobat Connect Professional). *Journal of Online Learning and Teaching*, 3(4). <http://jolt.merlot.org/vol3no4/hilbelink.htm> (accessed 21 May 2009)
- Schulmeister, R. 2006. *eLearning: Einsichten und Aussichten*. Oldenbourg, München.
- ten Dam, I., 2006. Multi - usable courseware for flexible and demand - driven education at ITC. In: *ISPRS Technical Commission VI Symposium : E-learning and the next steps for education*, Tokyo, Japan, 27 - 30 June 2006, pp. 84-88.

6.1 Acknowledgements

The author wishes to thank Tom Loran, coordinator of E-learning projects and distance courses at ITC, for enabling the participation in the ISPRS workshop. Further thanks go to Armelle Richard from Elluminate for providing the tool to be used for the DE SDSS in 2008 and to Scott Garrigan from CAPE - Center for Advancing Partnerships in Education for making me acquainted with it. Special thanks go to Linlin Pei and Heike Koeckler for valuable comments on the text.

ENHANCING STUDENTS' ABILITY IN READING CONTOUR MAPS USING GIS

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Commission VI, WG VI/4

KEY WORDS: Digital Terrain Models, E-Learning, Map Reading

ABSTRACT:

Terrain relief is an important feature of geographic environment and a major element of topographic maps. Contour lines are widely adopted as representation of terrain relief in traditional maps. In general, contour maps are still indispensable due to the following reasons: 1) Abundant terrain data are still represented by contour maps; 2) Contour maps contain fewer limits for use in different situations; 3) Reading contour maps can train students' logical thinking. Yet, contour maps are difficult to comprehend for most students due to their abstract nature. This research takes into account three essential elements involved in contour interpretation: terrain information, map representation and spatial cognition. We incorporate these elements into the creation of terrain relief using GIS and computer mapping software, such as ArcMap and Surfer. The representation being developed include vivid ones and abstract ones so that students can learn to comprehend abstract representations of terrain relief, such as contour maps, through vivid representation. A teaching module composed of these representations is developed and tested before serving as a teaching supplement to geography teachers. It is anticipated that this will contribute to geography teachers' instruction of contour map reading and facilitate students' map cognition process.

1. INTRODUCTION

Terrain relief is an important feature of the natural environment, influencing human activities and the spatial distribution of many natural and human phenomena. How to represent terrain relief is always a vital theme for discussion in cartography (Imhof, 1982). Traditional paper maps can represent terrain relief in diverse ways, but each way provides different information and has its own advantages and weakness. Among traditional maps, contour maps document rich information, and are widely used for various purposes. The ability to read contour maps is hence broadly considered as a basic map reading ability that students should possess.

Taiwanese junior and senior high schools have hence included contour map reading as a skill that should be cultivated in geography curriculum (Ministry of Education, 2008). Many students, nevertheless, believe this is a difficult theme to learn. Questions about contour map reading also appear very often in Taiwan's entrance examination for high schools and universities. Participants, however, in general do not perform well in such type of questions. For lecturers alike, many feel that teaching contour reading is a challenging task.

During the past thirty years, the advancement in geographic information system (GIS) has enabled diverse representation of topographical information. Three dimensional (3-D) spatial representation, in particular, makes topological representation much more precise and concrete. It is easier for normal people to understand 3-D representation. Despite such development, contour maps are not completely replaced by computerized representation. The crux of this paper lies in introducing a number of examples to show how the representational functions of GIS and 3-D dynamics can help students comprehend abstract concepts of contour lines and further enhance their contour map reading abilities.

2. CHALLENGES OF REPRESENTING TERRAIN RELIEF

Maps provide a medium for information dissemination. The process of conveying geographic information involves the flow of messages between two entities: the real world and maps. Map-makers and map-readers play vital roles in encoding and decoding this information (Robinson *et al.*, 1978; Robinson *et al.* 1995). Below we explain three aspects of factors that affect the dissemination of topographical information (Figure 1).

The first aspect concerns *terrain relief in the real world*. Terrains are 2-dimensional existing in 3-dimensional space. One can thus consider terrains as 2.5-dimensional, changing a continuous smooth dimension. Any point on the earth surface has an altitude. Any such point can be a part of a plain, hill, or mountain. In addition, altitude can be extended to measure features such as the steepness of slopes, aspect of slopes, and topography, etc. Different users require different topographic information. Researchers who study the potential threats of mudslides need accurate data of altitude, slope steepness, slope aspect of a hill. Experts designing the proper management of water resources need topography, ridge lines, and watersheds of a larger scope of area. The content of information that maps need to record and convey vary according to the users' needs.

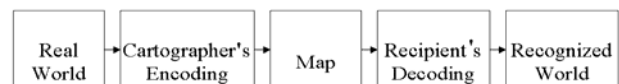


Figure 1. The process of map communication (Robinson, *et al.*, 1978)

The second aspect concerns *terrain relief shown in maps*. Early maps can already accurately document discrete objects such as houses, roads, and rivers because the positions of these features are discrete and clear, and because orthographic projection

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allows cartographers to represent how these features are seen as if they were looked down upon from the sky.

The challenge, however, lies in recording terrain relief. As said, terrain relief is a continuous smooth field (Robinson, *et al.*, 1995). The altitude and slope of every location cannot be completely recorded. Representing terrain relief is much more complicated and difficult than representing roads and houses. This requires a highly abstract way of thinking and representation. As a result, more than ten diverse methods have been developed to represent terrain relief. A summary of these methods can be found in section three of this paper.

The third aspect concerns *cognized terrain relief*. The ability to use maps involves the cognitive ability of users; this is related to the users' mental development. Students possess different abilities to cognize the environment and to understand space. This further leads to variation in interpreting and utilizing maps. Age, gender and attitude of students can also explain such variation. Education, however, plays vital roles in minimizing such variation and in assisting students to enhance their map reading abilities.

In the following sections, we begin with a discussion of a number of methods that have been used to represent terrain relief. In the fourth section, we show how GIS and 3-D technology can be combined to assist students in reading contour lines. Section five concludes our discussions.

3. METHODS OF REPRESENTING TERRAIN RELIEF

No single representation method can satisfy all users' needs. With the development of cartographic techniques, nonetheless, more representation methods emerge, and less satisfying methods began to fade. By reviewing secondary literature and maps, we summarize six kinds of 2-D representation of terrain relief (Imhof, 1982).

3.1 2-D Static Representations

3.1.1 Lateral Protrayal: This method directly represents terrain relief perceived in human eyes. It is close to human daily experiences. This type of maps, however, cannot precisely record the many features of terrain relief. Moreover, the data obtained in this kind of maps cannot be integrated with geographical features represented with orthographic perspective. Hence, such maps cannot present concrete coordinates.

3.1.2 Hachure: Hachure shows the orientation of slopes using different values created by different thickness and density of lines. It is suitable for providing a larger scope of topographical information, but it cannot offer detailed information of a small section of terrains.

3.1.3 Shading: Shading is created using simulation of sunshine projecting onto ground surface. This illustrates shades that are caused by the differences of terrain relief. Shading can represent 3-D terrestrial features. It is suitable for any scale of maps. The downside, however, is that it cannot represent accurate altitude or slope steepness.

3.1.4 Contour maps: Contour maps are illustrated with contour lines that join points of equal elevation above a given level. Topographic maps are generally contour maps. Contour maps provide accurate terrestrial information. However, as said, this kind of representation is very abstract. Normal readers must undertake some training before being able to interpreting it.

3.1.5 Hypsometric Tinting: This method is created on the basis of contour maps. Different levels of altitude are marked with different colors. Although hypsometric tinting differentiates various levels of altitude in a general way, it cannot present further details of terrestrial features.

3.1.6 Colored Shading: Colored shading combines hypsometric tinting, generating colored terrestrial shading. This kind of representation contains rich information, and is easy to read. It is becoming more popular. But it is still not able of offering clear information of altitude, slope steepness, and slope aspect.

3.2 3-D Dynamic Representations

GIS collects, processes and analyzes all kinds of geographic information. It accepts various kinds of data input, offers various types of information products, and shows multifaceted models of geographic features (Guptill and Starr, 1984).

Currently, in GIS, digital terrain model (DTM), a 3-D surface composed of a mesh of data points, helps display 3-D terrestrial features. 3-D visualization is closer to human visual experiences, thus facilitating the transmission of information. Many GIS software packages offer 3-D visual simulation. For instance, in ESRI ArcView 3D Analyst, Surfer and ERDAS Imagine Virtual GIS, we can overlay digital terrestrial models with high resolution of terrain images, creating a good visual simulation. Google Earth also has provided similar functions on the Internet, inviting more people to understand terrain relief online. Below we summarize 3-D dynamics provided by GIS into the following four types.

3.2.1 Fishnet Maps: Fishnet maps allow users to observe terrestrial features, altitude, slope steepness, and slope aspect. However, fishnet maps cannot reveal absolute digital data. They also cannot show the terrain relief of an entire area. Since thirty years ago, there had been computerized fishnet maps, but their popularity has gradually disappeared.

3.2.2 3-D Topographic Maps: This representation is similar to that of fishnet maps, but it further combines remotely sensed imagery to show ground covers, offering a much more real effect of terrestrial demonstration. Because the data that needs to be processed is sizable, the development of 3-D topographic maps is behind that of fishnet maps.

3.2.3 Virtual Reality (VR): Virtual reality is a representation method created more than ten years ago. It is demonstrated via the World Wide Web (WWW). At that time, the most widely used way to establish virtual reality is to use VRML language. The way to create virtual reality is similar to that of creating fishnet maps and 3-D topographic maps, but it has an additional dynamic function that allows users to rotate view angles as they wish. Users can observe terrain relief from any angles and distances. It gives a better interactive opportunity. However, due to the limit of speed of that could be carried out by computers and the internet at that time, this kind of representation was not widely promoted. The most widely used Google Earth at this moment has offered effects that virtual reality could provide at that time.

3.2.4 Fly: Fly provides the same kind of topographic information that VR can offers. The effect is like when one observes ground features from an airplane. When showing topographic features using Fly, the user has to first choose a flying route. The computer will then simulate what the user could see on that route, and stores it as a flash file. However, since the flying route is fixed, Fly lacks flexibility of interacting with the users like what virtual reality can provide.

3.3 Summary

Dent (1996) believes that a good map should be aesthetically pleasing, thought provoking and communicative. In terms of information transmission, 3-D topographic maps and virtual reality, for instance, are characterized by their readability. But these maps provide limited topographic information. They can only show general terrain relief, not altitude, slope steepness and slope aspect.

In terms of the content of information, contour maps provide the most information and functions, but they are the most difficult to understand. For untrained readers, a contour map is composed of density of irregular lines which are difficult to comprehend.

As we can see, representation of terrain relief has changed from an emphasis of concreteness, to abstractness, and then again to concreteness over time. The earliest representation was close to human's direct experience. The development of hachure, contour maps and others make cartographic representation become more and more abstract. With the development of technology, GIS software's 3-D functions bring us back to concrete representation. Modern concrete representations, however, are greatly different from earlier concrete representations. Earlier representations were rough, and current GIS has accurate DTM as a foundation to generate precise 3-D images, and can be manipulated and calculated. If necessary, 3-D representation can also be turned into 2-D representation. In the fourth section, we show the combination of contour maps with 3-D functions, and make comparisons. We also demonstrate how this combination can assist the interpretation of contour maps in teaching modules.

4. CONTOUR LINE INTERPRETATION

4.1 Contour Line Reading

Every contour line records altitude. After reading altitude, students can further learn to read other advanced topographic information. Students' knowledge is built layer by layer from the simplest concept to the most complicated one. When learning new concepts or skills, students should learn step by

step in order to reduce learning difficulty and reach a higher level of learning outcome.

To interpret altitude, ridge line and valley lines extraction mean different levels of challenges. The objective of the following module is to acquaint students with these concepts:

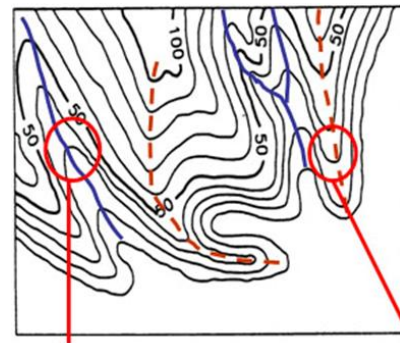
4.1.1 Altitude: Any point's altitude can be estimated from the altitude of the two contour lines below and above this point.

4.1.2 Slope Steepness: Any slope steepness between two points can be estimated by calculating the altitude differences and the horizontal distance of the two points. Density of contour lines can also show the difference of slope steepness. Within the same distance, the more dense the contour lines are, the steeper the slope is, and vice versa.

4.1.3 Slope Aspect: The orientation of a slope can be told by observing the direction that is perpendicular to contour lines. This direction also shows the flows of water.

4.1.4 Slope Pattern: From the density of contour lines of a slope, one can tell the pattern of the slope. When the upper slope is not so steep and the lower slope is steep, one observes a convex slope. When the upper slope is steep and the lower slope is not so steep, one observes a concave slope.

4.1.5 Valley Line and Ridge Line: Valley line is a narrow lower land between two mountain ranges. It is usually the route where a river flows through. It is connected by the lowest point of contour lines. Ridge line, by contrast, is connected by the highest points of contour lines. In contour maps, both terrains appear in V-shapes. If the tip of the V-shape points to a higher location, it is a valley line. If the tip of the V-shape points to a lower location, it is a ridge line. By including ridge lines and valley lines in a map, one can see the water basin and river networks of an area (see Figure 2).



Valley line: V-shape points to a higher location

Ridge line: V-shape points to a lower location

Figure 2. Ridge Lines and Valley Lines in Contour Maps

4.2 Contour Representation

GIS software offers diverse representation methods. One can use DTM data to produce hachure, colored shading, contour and other traditional maps. GIS can also produce fishnet maps and 3-D maps, simultaneously using dynamic representation to observe terrain relief from different distances and angles.

In order to let students understand abstract contour lines, teachers can select a number of special terrains, extract their DTM data, and use ArcMap 3D Analyst software to combine colored shading and contour maps. Next, teachers can use Surfer software to create 3-D dynamic representation. Colored

shading shows static 2-D representation, while Surfer allows dynamic representation. Unless the teachers use Surfer in class, students cannot see dynamic representation, but only simulated 3-D static images. Below are some typical examples of terrain relief.

4.2.1 Hill:

Terrestrial feature: Low altitude (mostly within hundreds of meters); little relief.

Reading skill: contour altitude is within 500 m; relative altitude is below 200 m.

4.2.2 Volcanic Cone:

Terrestrial feature: Cone-shape mountains; altitude ranges from hundreds to thousands meters.

Reading skill: Contour lines appear in the shape of concentric circles; central altitude is high and surrounding altitude is low; the difference between middle and surrounding altitudes is hundreds of meters.

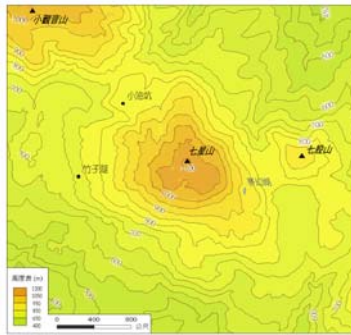


Figure 3. Volcanic Cone Contours

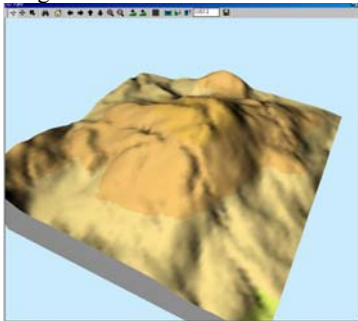


Figure 4. Volcanic Cone 3-D Colored Shading

4.2.3 Tableland:

Terrestrial feature: High altitude in the middle; it is flat and smooth in the middle; surrounding slopes are steeper.

Reading skill: Values of contour lines in the middle are high; few contour lines in the middle, indicating there is a flat terrain; surrounding contour lines are dense, indicating steep slopes.



Figure 5. Tableland Contours

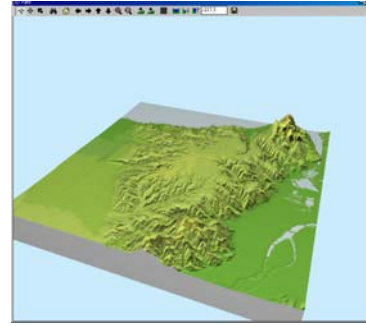


Figure 6. Tableland 3-D Colored Shading

4.2.4 Basin:

Terrestrial feature: A bowl-shape terrain where the surrounding areas are high and the middle is low.

Reading skill: Few middle contour lines and their altitudes are low; dense contour lines in surrounding areas and their altitudes are high, indicating hills or mountains.



Figure 7. Basin Contours

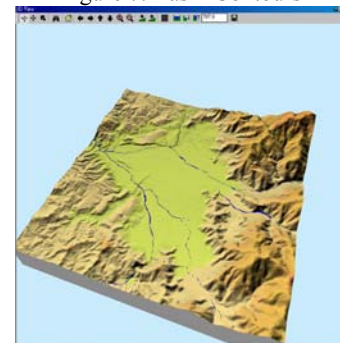


Figure 8. Basin 3-D Colored Shading

4.2.5 Valley:

Terrestrial feature: Elongated lowland between mountain ranges, hills or other uplands.

Reading skill: Contour lines appear in obvious V-shape. The tip of the V-shape points to higher contour lines. Contour lines are particularly dense near the valley.

4.2.6 Alluvial Fan:

Terrestrial feature: It is a flat landform created by the deposition of sediment over a long period of time by rivers originating from highland regions.

Reading skill: Where the rivers flow into lowlands, contour lines appear in fan-shape concentric circles; there are few contour lines; the gaps between contour lines are regular, indicating there is a relatively flat and straight landform.

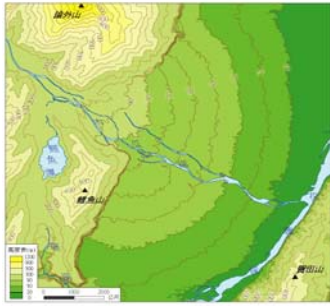


Figure 9 Alluvial Fan Contours

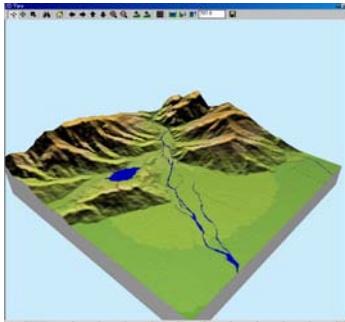


Figure 10. Alluvial Fan in 3-D Colored Shading

4.2.7 River Terrace:

Terrestrial feature: Steps that appear near river valleys, usually displaying discontinuous terrains caused by the rise of landforms or the descend of sea levels.

Reading skill: A mixture of dense and loose contour lines near river valleys; the loose part represents river terrace, while the dense part represents the slopes of terrace.



Figure 11. River Terrace Contours

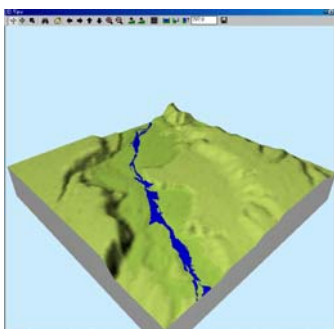


Figure 12. River Terrace 3-D Colored Shading

4.3 Representation by Google Earth

Since the aforementioned two software packages are commercial software packages, it might not be easy to obtain them for teachers and students. If this is the case, one can also consider using Google Earth because it also represents 3-D dynamics. Google Earth contains rich information. It is easy to use and is widely available. Its potential in K12 education is enormous. Recently, Google has provided Web interface's API for advanced users to customize websites. Based on Google Earth, users can add individual images and maps, making Google Earth an attractive platform for educational dissemination. Teachers can integrate kmz files of the above images to Google Earth so that students can try to experience dynamic representation of these static images online.



Figure 13. Tableland by Google Earth

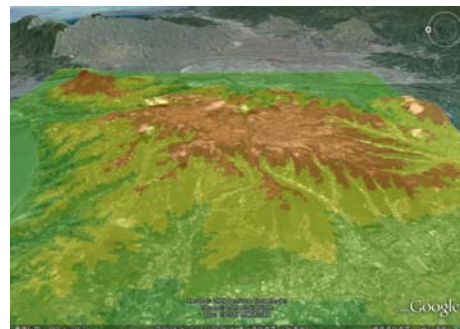


Figure 14. Tableland with hypsometric tinting in Google Earth



Figure 15. Alluvial Fan by Google Earth

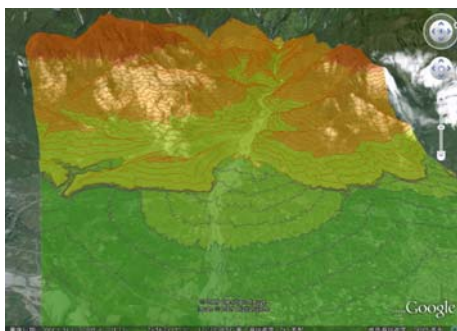


Figure 16. Alluvial Fan with Contours in Google Earth



Figure 17. Basin by Google Earth

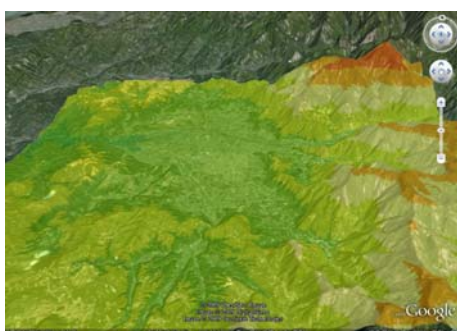


Figure 18. Basin with Hypsometric Tinting in Google Earth

5. CONCLUSIONS

It is an ideal for cartographers to provide rich and easy-to-read information on maps. Cartographic technology has been developed along this line of aspiration. Earlier or even ancient maps are easy to read because their makers usually produced them from the angles of the users. These maps, however, suffered from problems of inaccuracy and deficiency of information. With the diverse development of cartography, such as that of the hachure and contour, we find increasingly innovative ways of representing topography. The increase of information on these modern maps, however, tends to make maps less readable for users.

With the advancement of information technology, informational visualization permits dynamic and real-time style of representation. Users find that they can understand terrain relief from their own experiences, angles, and motives again like earlier maps used to. Because contour maps are widely used and contain abundant information, they are not easily replaceable by other representation manners. That is why in this paper, we exemplify a number of ways of incorporating GIS to help students increase their contour line reading ability. The importance does not solely lie in educational dissemination, but also in research on E-learning.

There is growing concern on the efficacy of E-learning technology in geography education (Lynch et al., 2008). Some argued that information technology may help increase students' interests in learning, but not necessarily change students' learning abilities. It is understandable that if information technology is simply used as a tool to invoke motivation and learning interests, then its effect can only be limited according to its pre-set objective. We believe that apart from invoking learning interests, information technology should also be applied in introducing concepts, helping students to construct and absorb knowledge. Incorporating GIS into the learning of contour maps shows one example of how information technology can help students understand abstract and difficult concepts.

This paper does not discuss further how students and teachers actually benefit from the proposed module. This behoves future study to find out.

REFERENCES

- Burrough, P. A. 1986. Principles of Geographical Information Systems for Land Resources Assessment. Oxford: Oxford University Press, Ch. 3
- Dent, B. D. 1996. *Cartography Thematic Map Design*. Wm. C. Brown Publishers: Dubuque, Iowa, USA.
- Guptill, S. C. & Starr, L. E. 1984. The future of cartography in the information age. In Morrison J L (ed) *Computer-Assisted Cartography Research and Development Report*, ICA Commission C, 1-15.
- Lynch, K.; Bednarz, B., Boxall, J., Chalmers, L., France, D. & Kesby, J. 2008. E-learning for Geography's Teaching and Learning Spaces, *Journal of Geography in Higher Education*, 32(1), pp. 135 – 149.
- Imhof, E. 1982. *Cartographic Relief Presentation*, Walter de Gruyter & Co.: Berlin, Germany.
- Ministry of Education, 2008. Senior High School Curriculum Standard for Geography, Taiwan.
- Robinson, A.H. ; Sale, R., Morrison, J.L 1978. *Element of Cartography*, 4th Ed., John Wiley & Sons: New York, USA.
- Robinson, A.H. ; Morrison, J.L. ; Muehercke, P.C. ; Kimerling, A.J. & Gultill, S.C. 1995. *Element of Cartography*, 6th Ed., John Wiley & Sons: New York, USA.

ACKNOWLEDGEMENTS

This research is supported by a research grant (NSC 98-2631-H-002-008) from National Science Council, Taiwan.

LEARNING MODULES – A WAY TO INTEGRATE REMOTE SENSING METHODS IN SCHOOL EDUCATION

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Commissions VI/1 - VI/2

KEY WORDS: Digital and interactive learning modules, remote sensing, school education, problem-oriented learning

ABSTRACT:

Despite political demands for a more intensive development of the subject of remote sensing in school lessons, it still plays an inferior role. It appears that many of the software solutions created explicitly for school lessons have not been introduced to school curricula due to their complexity. As a result, the subject is either not integrated in lessons at all or, at best, does not go beyond the level of analogue image interpretation. Yet because remote sensing represents more than just the visual interpretation of satellite images, it also requires the facilitation of basic maths and physics, as well as methodological and media competence. For the sustainable integration of remote sensing as a school subject, this paper therefore presents digital, interactive and interdisciplinary learning modules which can promote the methodological and media competence of pupils, as well as their independent study skills.

1. INTRODUCTION

As part of the aerospace industry, remote sensing represents a key technology in our modern-day information society and is attached with an increasing degree of economic relevance. Among other things, this is reflected in the continual development of new sensors such as TerraSAR-X and RapidEye, and in the growing need for qualified employees. In addition, satellite images are affecting our everyday lives more and more – and not just through the weather forecasts in the news, either. In news coverage, remote sensing data is also being increasingly implemented in reports on natural disasters or the global climate change. Moreover, a poll has revealed that 80 percent of German pupils use Google Earth on a regular basis. The programme was downloaded over 100 million times in 2006 alone.

Against the background of the growing relevance of issues revolving around global environmental changes—also in the media—, as well as a high demand for employees in the area of engineering and natural sciences, remote sensing can help get pupils interested in these topics with its fascinating satellite images and modern technology.

Apart from giving school curricula a stronger scientific focus (Stork, Sakamoto, Cowan, 1999, Bednarz & Whisenant, 2000, Sneider, 2000, Merry & Stockman, 2001), the adoption of remote sensing in school lessons holds a range of additional advantages

- Remote sensing data offers the possibility of handling a range of curriculum-specific topics in the school subjects of geography, biology, maths, physics and computer science – in a **problem-oriented and integrative** manner.
- The high degree of topicality and multitude of spatial, temporal and spectral resolutions of remote sensing data make it possible to work on **up-to-date** and **dynamic problems**.
- The graphic quality of the data allows for a **new view** of certain problems and offers a **high degree of vividness**.

- Through the combination of images and technology, remote sensing data has a **motivating and fascinating effect** on pupils.
- By working independently with remote sensing data, students' **methodological skills** can be facilitated in the area of data processing, general computer work and digital image processing.
- The use of remote sensing in school lessons allows new forms of teaching, learning and instruction methods to be put into effect.

Due to this diverse range of advantages, there has already been an ongoing discussion for years now about using satellite images more heavily as an additional medium in school lessons (Ante & Busche, 1979, Brucker, 1981, Frömel, 1981, Hassenpflug, 1999, Theissen, 1986). Accordingly, a stronger use of modern media and working materials are explicitly called for in the latest formal curricula and education standards of the Deutsche Gesellschaft für Geographie (DGfG – German society for geography) – at least for the subject of geography. In some German states, the use of GIS and remote sensing is even explicitly compulsory. Despite this development, the topic of satellite remote sensing still plays a subordinate role in European schools (Neumann-Meyer, 2005, Siegmund & Menz, 2005, Reuschenbach, 2006, Reuschenbach, 2007a).

In addition, it is noticeable that satellite images are primarily used in geography lessons, if they are even put to use at all in school lessons. Due to strict specifications in the curriculum, however, teachers often only have a relatively small window to integrate new topics in their geography lessons. In such, satellite images are often only integrated to demonstrate topics relevant to the curriculum. Without an intensive examination of the image data though, the pupils' methodological skills cannot be cultivated. This is why Reuschenbach (2007a) developed a volume of transparencies and working materials for the subject of geography, years 5 to 13, which aims at facilitating the intensive study of satellite images. With this approach, remote sensing is integrated in the lessons in the form of an analogue medium: colour transparencies. The satellite images of the 32

colour transparencies in total are embedded in a problem-oriented manner in various geographical fields and serve as working materials for answering different geographical questions. The advantage of this approach is that it promotes both the visual competence and spatial orientation of students (Reuschenbach, 2007b).

However, remote sensing encompasses more than just the purely visual interpretation of aerial and satellite images, meaning that this method only covers one area of remote sensing's topic spectrum. Essentially, the approach neglects the physical and mathematical fundamentals of remote sensing, as well as contact with "new media".

To avoid this reduction, there are and have been efforts to integrate the topic of remote sensing in school lessons with software explicitly developed for pupils (e.g. LeoWorks or MultiSpec). Despite the fact that these programmes were created especially for use in school lessons, it seems they have not been widely introduced to school curricula due to their complexity. A survey of involved teachers conducted within the scope of the University of Bonn's project "Fernerkundung in Schulen (FIS)" (remote sensing in schools)* showed that getting accustomed with these programmes is too time-consuming and requires too much effort. In addition, many of the interviewed teachers shy away from the complex installation procedure for these programmes.

In order to promote a more intensive use of remote sensing in school lessons, a new didactical concept was developed within the scope of the FIS project at the Geographical Institute of the University of Bonn, which is sponsored by the German Federal Ministry of Economics and Technology. This concept goes beyond the level of analogue image interpretation, examining remote sensing in its entire breadth including physics and maths basics. For the actual digital implementation, however, elaborate and complex software solutions have been avoided. Instead, the use of digital, interactive and interdisciplinary learning modules is seen as a sustainable and practical solution for use in schools, as they can promote the methodological and media competence of pupils, and cultivate their independent study skills.

2. TEACHING PLAN

Alean & Biber (2005) summarise the advantages of remote sensing for school lessons as follows: "*Satellite images clarify, highlight issues and attract attention. Mostly, however, they allow students (...) to recognise correlations themselves.*" (Alean & Biber, 2005:35; freely translated from the German).

For this reason, the subject of remote sensing is integrated in school lessons with bifunctional, interactive and digital learning modules in order to sustainably convey the subject matter through animation and interaction. Intensively working on problems and solving assignments pursue the objective of giving pupils a better understanding of the computer medium not only as a purely informational and entertaining device, but also as a tool. Through practical work on computers and subsequent experimentation, investigation and analysis, the latest range of topics in the area of information processing are examined so that pupils' general exposure to electronic data processing is improved. Accordingly, students' methodological and media competence is promoted through practical use and application. In the sense of constructivist didactics, the interactive learning modules also facilitate their independent

work skills. The teaching units therefore aim at more than just providing background information, images, animations and assignments; they also zero in on the independent examination and solution of problems.

In addition, the following objectives are pursued:

Facilitation of networked learning – Due to the complexity of the remote sensing subject, the topic itself is split up between numerous school subjects (cf. Voss, Hodam & Goetzke, 2008). The theoretical and physical basics are conveyed in maths, computer science and physics classes. As a result of this, the theoretical fundament for a user-oriented integration of remote sensing in geography and biology lessons is established in these three basic subjects. Through the targeted collaboration between different school subjects, pupils' ability to think in a networked manner, determine interdisciplinary correlations and look at things holistically are all facilitated (White, 2001).

Sustainable integration of remote sensing as a subject – To permanently integrate remote sensing topics in school lessons, the subject has to be linked to the teaching units already anchored in the curriculum. This not only increases students' motivation to work on classic coursework, but also boosts the learning spectrum because contents and methodological aspects of remote sensing are conveyed in addition to the subject matter foreseen by the curriculum (cf. Voß, Hodam & Goetzke, 2008).

Fostering of competence – Through a constructivist approach and intensive occupation and analysis with satellite images, different skills are fostered in pupils. These primarily include visual competence, methodological and media skills, and the ability to work independently.

Compared to teacher-oriented methods of instruction, the entire pedagogic concept is distinguished by students' active participation in class. By actively incorporating pupils in the lessons, the teacher's role transforms into that of a learning coach (see above; cf. Voss et al. 2008).

3. EXAMPLES OF INSTRUCTION

Based on four examples, it will be shown here how digital learning modules can be utilised in the subjects of physics, computer science, maths and geography. Correspondent to sustainable integration, the learning modules are linked with existing topics in the curriculum. All digital learning modules are characterised by a high degree of interactivity so that pupils are given the necessary room for an intensive examination of the subject matter by actively and independently working with the learning module. Their understanding should primarily be supported and facilitated by the diverse range of interactive options.

For example, students can independently combine different spectral channels with one another, and directly examine and gain a grasp of the differences in the image. To promote intensive work with contents, every modular unit has a quiz at the end which tests students' newly acquired knowledge. Only when pupils have correctly answered the questions can they move on to the next unit. This quiz is viewed as an aid for students because it does not directly confront them with the entire subject matter, which would possibly "swamp" them. Once a modular unit has been successfully completed, pupils can switch back and forth between the units to repeat or review contents before answering any of the questions that follow.

* Sponsored by the German Federal Ministry of Economics and Technology; project management DLR

3.1 Physics – On the Trail of the Invisible

In the German state of North Rhine Westphalia, the physics curriculum for secondary schools foresees the subject area of physical optics. This is split up into three subgroups: light on the surface, optical lenses and the sight procedure and optical instruments.

Satellite images could form a sort of bridge between these three topic areas, as the physical basics of satellite remote sensing range from the actual exposure itself to the “finished” satellite image. The **goal** of the teaching unit called “On the trail of the invisible” is to understand connections between the electromagnetic spectrum, reflectance, absorption, exposure and development of satellite images. As a result, the topics from all three sub-groups are set in correlation with one another.

All together, this teaching unit is comprised of numerous components. The first part of the learning module introduces pupils to the subject of reflectance: together with a virtual professor, they conduct a playful experiment on the reflectance of various objects, the goal of which is to determine the characteristics of the objects in terms of their reflectance attributes. In order for students to tie into their own experiences and everyday background knowledge, the first modular unit concentrates on the area of visible light in the electromagnetic spectrum. In the second modular unit (fig.1), students can then transfer their newly acquired knowledge from the virtual laboratory to a satellite. Accordingly, the goal of the second part of the learning module is to understand how a satellite actually works. The focus of attention is thus on the following question: how does a satellite convert the reflectance signals it receives into colour image information? In the last modular unit, an overall look at the electromagnetic spectrum is given, followed by a corresponding examination of whether a satellite can also use other wavelengths apart from the area of visible light.



Figure 1. Learning Module: On the Trail of the Invisible

3.2 Computer Science – Contrast Programme

The “Contrast programme” learning module ties into the themed areas “active principles of informatics systems” and “interaction with informatics systems”, thus facilitating an examination of data structures and digital image processing. The complexity of the module is designed in such that it can be used in years nine and ten.

Working with satellite images in this field is particularly suitable because with satellite images, the composition of digital images and fundamentals of digital image processing can be very vividly conveyed. The goal of the “Contrast programme” teaching unit is to learn to understand the basics of digital image processing.

In the first part of the learning module (Fig. 2), students are introduced to the general subject of digital image processing. A section of a satellite image showing the Statue of Liberty is provided for this purpose. Once students launch the learning programme, an initial image will be output, which holds two problems: 1. it is relatively low-contrast and 2. it contains two “erroneous” pixels. To first get a grasp of how digital images are composed, pupils interactively determine the position of the

two “faulty” pixels. To do so, they can scroll with the cursor integrated in the image over the input section for the numerical values for the image’s column and scanning line.

In the second modular unit, students correct the grey scale values of both faulty pixels in the image. To do this, they can refer to the information box to find out all about 1, 2, 3, 4 and 8-bit images. The additional information box also addresses the correlation between the available grey scale values for different bits and the binary notation of the grey scale values. To further their knowledge, students should interactively correct the grey scale values of the faulty pixels by entering the correct combination of binary values. For a simplified introduction to the matter, a 4-bit image is provided at first. In the next step, both pixels are corrected again, but in an 8-bit image this time.

The last part of the learning module (Fig.2) is focussed on improving the image’s contrast. The image’s distribution of grey scale values is shown in a bar chart. Pupils are then asked to inform themselves of the range of values the image’s pixels take up. Finally, they can interactively adjust this range of values to improve the image’s overall contrast.

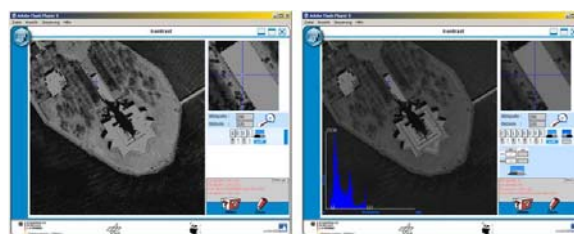


Figure 2. Learning Module: Contrast Programme

3.3 Maths – Pixels Gone Wrong

The learning module “Pixels gone wrong” was conceived for year eight and deals with the combination of linear functions and the geometric correction of remote sensing images. The learning module encompasses four parts in total. The first modular unit comprises an animated introduction in which the problem is briefly outlined (Fig. 3): *“The preliminary construction on an important building project was swamped by floods this past winter. Now an aeroplane is supposed to scan the construction site from the air, in order to show the extent of the damage. Just as the aeroplane is nearly over the target area, it is blown off its course by a gust of wind. The image of the site is now blurry and can’t really be used... unless this error is mathematically corrected.”*

Based on this introduction, students then have to sum up the core of the problem in part two of the module. They are provided with two images to do this: an undistorted image for comparison and the blurry image. The objective is to compare both pictures and accurately specify and describe the differences between the two. For the detailed image analysis, pupils are provided with a tool with which they can enlarge a cropped section in both images. The difference in the position of the pixels can thus be precisely determined and described. Through their intensive work with the images and detailed description of the differences in the pictures, pupils’ visual and lingual skills are also promoted, even in maths.

To acquire additional background knowledge, students can do some research in an information box. This provides them with fundamental information on the subject of pixels and digital image composition. The knowledge acquired here makes it possible for them to verbally formulate what a computer application has to do to get the pixels back into their correct position. In such, the first connection between the distorted

aerial image and maths can be established, and mathematical knowledge can be transferred to a specific, real situation.

In the third modular unit, a link is then made between mathematical basics and the practical example by searching for a simple linear function to correct the image. For this task, students are provided with the distorted

image, details on the aeroplane's deviation from its optimal flight path, and a coordinate plane. Calculating the real dimensions of the scanned area in pixels allows the distortion to be described as a graph in an interactive graph module. By calculating and adjusting the corresponding function, students come closer to a solution.

In the fourth modular unit, pupils can then test their calculated and adjusted functions by entering their results in an input field in the module. The image is now displayed based on the function they input. This also means that an unsuitable function will output an erroneous image. However, because this incorrect output is also the result of a function, it is easy to grasp and helps pupils understand how a function works.

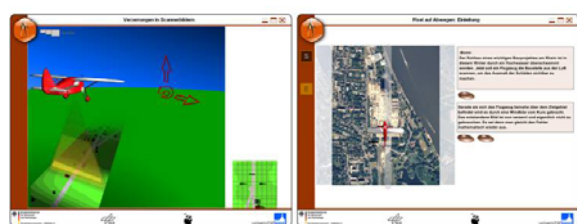


Figure 3. Learning Module: Pixel gone wrong

3.4 Geography – Tsunami

The teaching unit “Tsunami” is part of a topic area in year seven which covers the endangerment of habitats. The goal of this teaching unit is to familiarise students with the meaning of natural disasters, to gain spatial cognition and do a spatial assessment, grasp the possible formations and causes of tsunamis, and get to know the possibilities remote sensing can offer for damage ascertainment.

To begin with, in the first part of the learning module pupils are introduced to the subject of natural disasters in general and tsunamis in particular by the professor they have already become familiar with in the physics module. Here students can gain background information on the tsunami that raged over South-east Asia in 2004 through a newspaper the professor is reading. In the second modular unit, the knowledge gained through the professor's virtual newspaper should be linked with two satellite images (one before the tsunami, one of the aftermath). Students are first asked to compare both satellite images by using an interactive controller, and to familiarise themselves with both images (Fig. 4). Then they have to name the structures that were destroyed by the tsunami. They should also put themselves in the position of the residents who lived in the disaster area, and reflect on the effects the damage had on them.

In addition, pupils are asked to consider the value of satellite images in such cases of natural catastrophes, and how these images can be used during these disasters. For this purpose, they can refer to the information box for more details where the procedure of change detection is also vividly explained in a short film. Once the pupils have grasped the concept of change detection, they can classify specific land surfaces in the last modular unit and, for example, ascertain how much of the land surface shown in the picture was flooded, or how much of the agricultural area was destroyed by the tsunami (Fig.4).



Figure 4. Learning Module: Tsunami

4. EVALUATION AND OUTLOOK

The learning modules finalised in the FIS project were and will be made available in the form of e-learning modules on the project's homepage (www.giub.uni-bonn.de/fis), i.e. e-learning modules v1.0 (Kerres, 2006) are provided to the partner schools, used in school lessons and evaluated throughout the entire process. The results of the evaluation show that the lesson plan developed in the FIS project can be implemented quite well in practice. In particular, teachers frequently emphasise the tightly-knit link with existing curricula, since a high degree of practicality is achieved through the topics' great relevance. Because teachers can also integrate the teaching units very well in their individual lesson plans, a sustainable use of the modules is warranted. As a result of this, the integration of the subject of remote sensing is described as a positive supplement to coursework. For one, satellite data is said to be more illustrative, which means that pupils learn and remember the contents of the lesson better. Second, this also boosts the learning spectrum because contents and methodological aspects of remote sensing are conveyed in addition to the subject matter foreseen by the curriculum. According to these qualitative testimonies, the use of satellite data is attributed with a high to very high degree of relevance for reaching educational objectives.

The results of the evaluation also show that the compiled digital learning modules can be put to good practical use in school lessons. This practicality is assessed so strongly mainly because the modules can either be directly launched from a CD-ROM or integrated in existing in-house learning platforms without having to install any proprietary software in advance. The teachers surveyed attributed significant added value to the digital learning modules, both in terms of their use in comparison with analogue satellite images (as e.g. transparencies) and in comparison to existing software solutions (Fig.5).

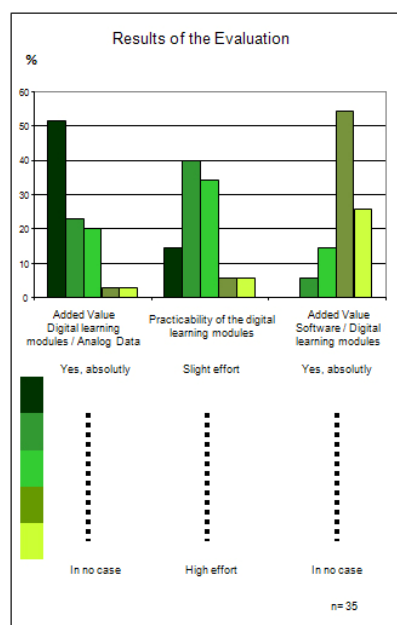


Figure 5. Results of Evaluation

The reason for this is that existing software solutions developed for use in schools are not actually suitable because they usually do not have any scalable approach, and are often not intuitive or user-friendly in their application. In addition to this there are organisational difficulties teachers often experience when they are not authorised to install new software. This in turn makes long-term planning necessary, which is often not easy to coordinate with everyday school life.

Due to the positive feedback on the practical use at schools, we plan on expanding and supplementing the existing learning modules both in terms of their content and in a methodical sense. This will allow us to ultimately provide an extensive collection of interdisciplinary learning modules for school lessons.

5. REFERENCES

- Alean, J. & Biber T., 2005. Entdeckendes Lernen mit Satellitenbildern. *Geographie heute* 235, pp. 35-37.
- Ante, U. & Busche D., 1979. Hindernisse beim Einsatz von Satellitenbildern im Geographieunterricht. *Geographische Rundschau* 31 (2), pp. 82-86.
- Bednarz, S.W., Whisenant, S.E., 2000. *Mission geography: linking national geography standards, innovative technologies and NASA*. IGARSS Proceedings, Honolulu, USA, pp. 2780-2782.
- Brucker, A., 1981. Sehgewohnheiten ändern. Satellitenbilder als Medien im Geographieunterricht. *Praxis Geographie* 11 (1), pp. 2-3.
- Frömel, W., 1981. Die Reaktion von Schülern auf Satellitenbilder. *Praxis Geographie* 11(1), pp. 15-17.
- Hassenpflug, W., Riechelmann, L., John, W.D., 1999. *Promotion of Remote Sensing in school education in Germany*. IGARSS Proceedings, Hamburg, Germany, pp. 2714-2716,
- Hassenpflug, W., 1996. Satellitenbilder im Erdkundeunterricht. *Geographie heute* 137, pp. 4-11.
- Merry, C.J., Stockman, S., 2001. Educational outreach activities for Landsat-7. *Remote Sensing of Environment* 78, pp. 217-220.
- Neumann-Mayer, U., 2005. Der Zugang zu Satellitenbildern in der Orientierungsstufe – Probleme und Möglichkeiten. Dissertation an der Universität Kiel. http://e-diss.unikiel.de/diss_1657/ (accessed 11.04.2008)
- Reuschenbach, M., 2006. *Fernerkundung im Geographieunterricht: Konzept zur verstärkten Integration von Satellitenbildern in den Geographieunterricht*. Beiträge zur Tagung des AK Fernerkundung; Institutsreihe der Universität Osnabrück, Institut für Geoinformatik und Fernerkundung (IGF), S. 79-90.
- Reuschenbach, M., 2007a. *Neue Wege der Fernerkundung im Geographieunterricht*. Tagungsband zur Dreiländertagung der Schweizerischen Gesellschaft für Photogrammetrie, Bildanalyse und Fernerkundung (SGPBF) in Muttenz. Publikation der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation e.V., 16, pp. 35 – 40.
- Reuschenbach, M., 2007b. *Lernen mit Luft- und Satellitenbildern. Folien und Arbeitsmaterialien für die Klassen 5 – 13*. Seelze.
- Siegmund A. & Menz, G., 2005. Fernes nah gebracht – Satelliten- und Luftbildeinsatz zur Analyse von Umweltveränderungen im Geographieunterricht. *Geographie und Schule* 154, pp. 2-10.
- Sneider, C.I. , 2000. *Activism or education? Implications for achieving science literacy*. IGARSS Proceedings, Honolulu USA, pp. 41-43.
- Stork, E.J., Sakamoto, S.O., Cowan, R.M. 1999. The integration of science explorations through the use of earth images in middle school curriculum. *IEEE Trans. Geosci. Remote Sensing* 37, pp. 1801–1817.
- Theissen, U., 1986. Das Satellitenbild. Köck, H. (Hrsg.): Grundlagen des Geographieunterrichts. *Handbuch des Geographieunterrichts* 1, pp. 268-270.
- Voß, K., Goetzke, R., Hodam, H., 2008. *Wie wird das Thema „Fernerkundung“ im Unterricht angenommen? – Erste Ergebnisse einer Fallstudie*. Jekel, Koller & Strobl (Hrsg.): Lernen mit Geoinformationen III. pp.8-14.
- White, S.J., 2001: *Enhancing instruction in mathematics and science in secondary schools: an innovative approach using remote sensing*. IGARSS Proceedings, Sydney, Australia, pp. 2480-2482.

6. ACKNOWLEDGEMENTS

The project "Remote Sensing in schools" is funded by the Federal Ministry for Economics and Technology (BMWi) by the German Aerospace Agency (DLR) (50EE0615).

Translated by Jenna L. Brinning

REMOTE SENSING IN SCHOOL – THEORETICAL CONCEPT AND PRACTICAL IMPLEMENTATION

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KEY WORDS: Geography, Teaching, Education, Internet/Web, Software, Interactive learning games

ABSTRACT:

Due to the importance and presence of remote sensing in science, industry and the public, the use of satellite imagery is now propagated for or even included in school curricula and the national educational standards for geography. Remote sensing data are characterized - in addition to their high clarity and timeliness - by having a great educational potential. This has been insufficiently tapped in school practice.

This paper presents a modern didactical concept and examples of practical implementation. It begins with the results of an international comparative study of the use of satellite images in schools as the basis for a didactical concept for using this medium in school. Furthermore, examples of implementing this theoretical model from different school types and grade levels will be shown. For the lower secondary level, interactive learning games concerning the basic functionality of remote sensing have been developed. Moreover, for both the lower and upper secondary level as well as for non-formal education, the creation of remote sensing tools on selected topics such as global change and urbanization is in progress. Another example is the development of web based software for the analysis of satellite images in school.

These examples of implementing remote sensing in education demonstrate the possibilities of a problem-and action-oriented use of remote sensing as a modern medium and tool of geography teaching. The materials foster different competencies of students and promote education for sustainable development.

1. INTRODUCTION

Working with remote sensing data in school is often reduced to analogue applications e.g. to examine different points of view for one area or to improve map reading skills. In times of GoogleEarth, geo-caching and navigation-systems children and teenagers are mostly conversant with using new techniques and new software. So why not use digital remote sensing data in class? Besides the teachers' personal misgivings, lack of suitable tools to work with satellite data for different class levels can be seen as impediments for application. Requirements regarding the tools' functionality and interface design differ considerably between younger and older students. Consequently, a concept has been developed to offer optimized tools for different age groups, proficiency levels and school types. The tools include interactive learning games, web based remote sensing applications and software to analyze satellite data.

2. INTERNATIONAL COMPARATIVE STUDY

At present, a geographical concept for remote sensing didactics is missing and therefore the different viewpoints of teachers and pupils about the extent and kind of satellite images that are used in lessons have been examined in an international online questionnaire. In addition to the personal and school surroundings, the technical ability of the pupils in handling satellite images has been examined. The participating countries were chosen based on the results of the 2003 PISA study in natural science competence. Countries above, at and below the OECD average have been selected. Target schools are secondary schools with pupils aged twelve to eighteen years.

The questionnaires for teachers and pupils are available in the respective languages (www.ph-heidelberg.de/satbild).

As the research project is not concluded yet, only preliminary results can be presented. Correlations and final analysis are forthcoming.

For example first results of selected countries show that in Germany, Poland and England more than 50% of the pupils have already worked with satellite images in school, in England more than 80%. In Turkey, South Korea and the US less than 50% of the pupils have worked with satellite images. First analyses also show that satellite images have a great potential when used in school. In all six countries more than 70% of the pupils answer with exactly/almost true when asked if the work with satellite images was interesting. In comparison, the motivation – as an important determinant for an effective learning process – is in almost all the countries significantly below the interest (see figure 1).

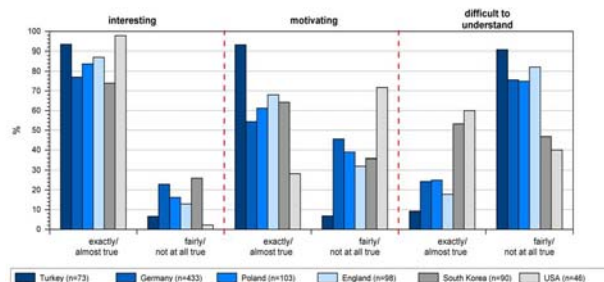


Figure 1: To work with satellite images in school was ... (Data base: own inquiry)

* Corresponding author.

Following steps must be the complete analysis of the empirical data and the correlations between different aspects. Altogether thirteen countries were involved so that a theoretical overall concept of remote sensing didactics for school could be developed.

3. “GLOKAL CHANGE” – COMBINING COMPUTER-BASED SATELLITE IMAGE ANALYSIS WITH FIELDWORK FOR AN EDUCATION FOR SUSTAINABLE DEVELOPMENT

By working with a web based learning management system (LMS), such as “Glokal Change”, students can learn about the complex relations of non-sustainable human activities and their subsequent environmental as well as economic and social impacts. For students of lower secondary school levels at the age of 10 to 16 years, it is hardly possible to understand the human induced environmental changes in their full complexity, and to comprehend the far-reaching impacts of human activities on the relationship between environment and human society regarding the ecological, economical and social dimensions. Using satellite image analysis is an important key to solve this problem. The LMS embeds satellite image analysis into a framework of education for sustainable development, demonstrating the possibilities of a problem- and action-orientated usage of remote sensing media as a modern tool for learning geography and environmental science. Thematic modules using satellite data from different points in time and of different band composites, at least for the local scale, allow for a comprehensive didactical approach to apply satellite image analysis to the education for sustainable development (see figure 2).

3.1 The Learning Management System “Glokal Change”

The project “Glokal Change – Evaluating global environmental changes locally” offers a web based learning management system for lower secondary school students which can be used in curricular as well as extracurricular environmental education. With regard to contents, the LMS refers to the subjects of geography and environmental science. As educational learning software, the methodical and didactical approaches being used within these subjects, especially within geography, are applied in the LMS. In our view, a multimedia-based configuration of the LMS with free navigation opportunities is very useful to give the students a more or less realistic presentation of the complex connections between human activities and environmental changes.

The project focuses on current non-sustainable human activities in the fields of forest management, digging and mining of non-renewable resources, cultivation of biofuels in agriculture and conflicts in land use. Each is the focus of one thematic module, and the four modules are linked among each other. Generally, this modular structure is the core of the LMS. Each module is treated in a problem-orientated manner, starting with the non-sustainable environmental change itself, e.g., the clearing of forests, or the cultivation of biofuels while many people in developing countries suffer hunger. In the course of the modules the view shifts from the global perspective with some international examples at the beginning to examples from Germany, and finally to the local surroundings of the students. The modules are composed of a mix of text elements, graphics, photos, flash animations and, especially, satellite images.

3.1.1 Using satellite image analysis

On the global to regional scale, examples of non-sustainable developments are visualized by two satellite images of the same region, but of different temporal origin. Satellite data offer actual spatial information which are easily available via the internet and cover the whole world. In the age of globalization and dynamic sampling of processes, they give students the opportunity to get to know the reality from places far away. Besides, using satellite data increases the motivation of students to deal with environmental topics. They are very useful because the impressive visualization of a geographical issue on a satellite image permits a better understanding of the spatial processes and circumstances which have been mapped. Students do not only learn how to deal with this remote sensing data but they also get to know how to “read” their content of geospatial information. Within the LMS, students can improve their ability to analyze the information about spatial and temporal processes and developments in the respective regions depicted in the satellite images (Brucker, 2006). According to Brucker (2006), satellite images are generally keys to the understanding for students that the earth is a closed ecological system, and that human interferences lead to global implications. Both aspects are essential to the project “Glokal Change” as it tries to demonstrate the environmental, and to a lesser degree the economic and social, consequences of human activities including satellite image analysis.

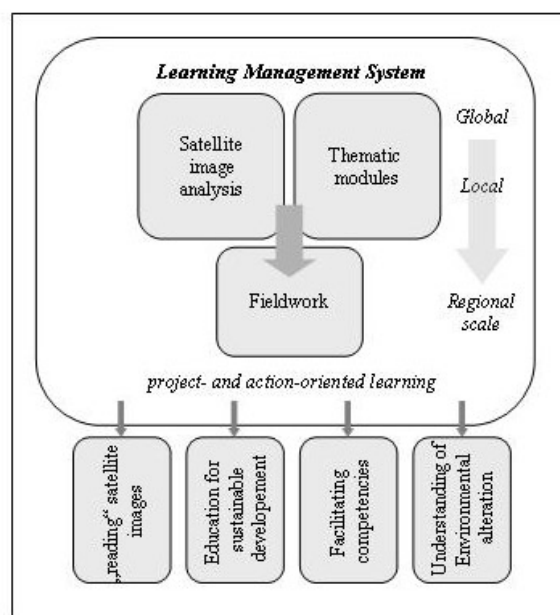


Figure 2: Structure and objectives of the learning management system “Glokal Change”.

On the local scale, satellite data from three different points in time, 1985, 2000 and 2007, and of three different band composites, true color images, false color images and images showing the Normalized Difference Vegetation Index (NDVI), help to intensify the learning process. For this purpose a mapserver, as part of the LMS, contains satellite image mosaics of the whole area of Germany for each of the three points in time and band composites. For 1985 and 2007 LANDSAT 4-5 TM images are used, while LANDSAT 7 ETM+ are used for the 2000 images. The mapserver offers several tools to work with the satellite image mosaics, namely zoom in/out, pan, search by zip code or geographic coordinates and measure. Moreover, a given position on the mosaic, e.g., a special building or an important position in the field, can be marked.

Additionally, an interesting satellite image detail can be printed or saved as a *.geotif data for further analysis in established image processing programs.

3.1.2 Using advantages through combining satellite image analysis and fieldwork methods

The third component of the LMS is a manual for corresponding action-orientated fieldwork, containing for example mapping instructions and interview guidelines (see figure 2). From our understanding, it seems important to complement the knowledge students' gained through working with the interactive learning modules and the mapserver with individual experiences in the field. This multi-perspective (global, regional to local) and multi-sensory ("head, heart and hand") approach aims at sensitizing students to the problems of current non-sustainable human-environment-interactions. Examining these relations is not only the basis for understanding the term sustainability but also for facilitating the individual cognitive competencies of each student. In the mainly geographically orientated context of the project "Glokal Change", the four modules are designed to meet the educational standards of the subject geography in German secondary schools introduced by the German Geographical Society (DGfG, 2008). The didactical concept of the project wants to activate and/or facilitate the following personal competencies as they have been denominated by the DGfG (2008):

- **Spatial orientation:** Students learn to orientate themselves virtually on a satellite image. During the fieldwork they learn how to orient themselves in real space. Combining both includes the ability to transfer the virtual orientation on the satellite image to the real conditions in the field.
- **Knowledge gain/methods:** Beside the satellite images other sources of information such as text elements or graphics activate and/or facilitate the student's ability to gain and to analyze information for the handling of geographic/geoscientific questions.
- **Communication:** Students shall improve their ability to understand and to express geographic/geoscientific messages via teamwork. Moreover students shall improve their way to come to a well-founded opinion.
- **Evaluation:** Students learn to evaluate selected situations and circumstances in space by using their geographic/geoscientific knowledge. Furthermore they learn to integrate ethic/social values and standards into their evaluation of geographic/geoscientific circumstances and processes.
- **Action:** Showing non-sustainable behavioral patterns on the one hand and quoting options for alternative sustainable patterns on the other hand activates and/or facilitates the willingness to act in geographically/geoscientifically relevant situations; this includes the students' ability to reflect their own action regarding spatial implications.

3.1.3 Using a microdrone

One part of the fieldwork is using a low-cost microdrone to map small local areas, e.g., razed forests or damages in cornfields (Thamm, 2005). The drone is equipped with a multispectral camera for high resolution aerial photos, which are usually used in forestry. Using the drone, pupils can find out the fundamental aspects of remote sensing like the high resolution of aerial photos, and this can yet be achieved in an action-orientated way enhancing the students' motivation. Another didactical approach for understanding remote sensing is the demonstration of taking aerial photos in real-time as an example of the origin

of satellite images. At the same time, students learn about the principles and difficulties of producing remote sensing data.

3.2 The contribution of remote sensing data to a more sustainable future

Overall, the intent of the project is to promote an active engagement of lower secondary school level students in non-sustainable environmental change and thereby increase their interest in questions of environmental protection. Students get to know personal and societal options for an alternative utilization of natural resources in order to make a more ecologically compatible, economically effective and socially righteous development in the 21st century possible (German UNESCO Commission, 2009). If we accomplish this task, the requirements of the present may be satisfied without cutting the needs of future generations. In this regard, satellite image analysis in combination with instructions for fieldwork is an important geographical/geoscientific didactically helpful method to call lower secondary school level students' attention to the problems of the present, and to inspire them for a more sustainable behavior in the future. At the same time, the students' acquisition of individual competencies can be facilitated.

4. BLIF: A WEB- BASED REMOTE SENSING SOFTWARE FOR SCHOOLS

In the age of „Google Earth“, nearly everyone is able to take a look on the earth from above. It is this kind of view of which Sokrates must have been dreaming when he stated: “We would understand the earth, if we could see her from aloft.” More than 2000 years later, the use of satellite images is known as key-method to understand the earth and learn more about its geoscientific correlations (Brucker, 2006). Real colour images, known from “Google Earth”, contain interesting and valuable information (Albertz, 2007).

The development of this unused source of information for a contemporary education in school is one of the core concerns of the didactics of remote sensing (Brucker, 2006, Siegmund & Menz, 2005). The project „Blickpunkt Fernerkundung (BLIF)” offers a web based software to establish remote sensing more frequently in school as a digital kind of modern learning.

The international comparative study about the interest and the motivation in using satellite images in schools has shown the huge educational potential of working with remote sensing systems in school (see chapter 2). Most pupils are highly motivated and fascinated by working with satellite images (Wolf & Siegmund, 2007, Voß, 2007). However, no computer application suitable for students to process and analyse remote sensing data on their own is available. Appropriate software solutions, which enable pupils to work with satellite images independently, are necessary to improve the various geographical and methodological skills demanded by German curricula (Roseeu, 2004).

There are several computer applications for professional users, such as ENVI, ERDAS, Idrisi, or eCognition. This kind of software offers a lot of possibilities to advanced users, but due to their complexity and non-intuitive user interface they are not appropriate to be used in school. Moreover, most of the mentioned software is too expensive for the majority of schools. “BLIF” provides a web based software to be used in normal classroom settings. The software is going to be developed and integrated into a didactical main concept. In addition to the software a great number of teaching aids to use the application

purposefully and activity-based will be provided. The characteristic feature of this application will be its intuitive, age appropriate usability.



Figure 3: Screenshot of BLIF-assistant-mode ("expert- mode"; stage of development: 05/10/2009)

There will be two modes. The first mode is the assistant guided mode, which is developed to introduce students in menu navigation (see figure 3). There will be three levels, starting with *beginners*, then the *advanced learners* and finally the *professional user*. Going through all the levels, the students will get accustomed to program procedure and learn how to process satellite images efficiently.

BLIF is structured into three main parts. The first one is the chosen satellite image area in the centre of the user interface. The second one is the menu bar above the image.



Figure 4: BLIF menu bar (Icons source: <http://www.visualpharm.com>)

The menu bar contains general software functions, like the folder-icon to open the satellite image, the disk-icon for storing individual processing steps, icons for zoom-in, zoom out, the undo and the forward button, the toolbox which contains special software features, the compass-icon for georeferencing, the layout button to design the results individually and the print button (see figure 4). The info icon will open an info-box, from which the BLIF user can get further information about the satellite image and the help-box.

The third main parts of the BLIF user interface are the framed content elements. By following the assistant's instructions, the students are introduced to the navigation of BLIF. Before starting a processing step, the user always gets the necessary information from the assistant, named "Satellitus". His advices are short and comprehensible, all important terms are hyperlinked to popup windows providing further explanations. The frame of the respective current processing level is highlighted (see figure 5). For instance, in figure 3 and 5 the students have to create a suitable band composition; consequently, the frame "band composites" is highlighted in red. By clicking on the "next-button", the students finish this step and the next frame with a new instruction is activated. According to the user-level settings at the beginning, the students will find various processing options. The "beginner" for example will not be able to improve the satellite image by using the histogram. Furthermore the beginner will not be able to make a histogram comparison or generate a "Normalized Differenced Vegetation Index" (NDVI) (see figure 5).

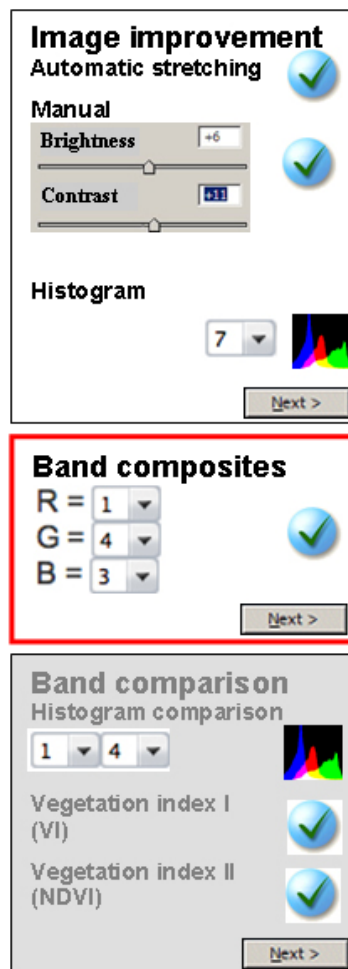


Figure 5: BLIF processing frame (cut out)

The second mode is the open form of using the software. The menu interface of both modes will be similar- but in the open mode it will be possible to have several special settings, depending on what kind of geographical question pupils want to explore and depending on their knowledge in using remote sensing systems. Because of these features, the software can be used by a wide range of user – ranging from beginners at the end of primary school to experienced users at the end of secondary school.

The technical features follow the most common utilities of remote sensing systems. Functionality will range from basic features (like importing and exporting files, zooming or the changing of vector files to image files and vice-versa), to

different possibilities for image improvement (regulation of brightness, contrast settings or stretching) up to the possibility of georeferencing. Another group of features consists of treating the image as well as several forms of image classifications. Here, the pupils have the possibility to build different band composites (see figure 6). By combining the information of certain spectral bands, the pupils can get helpful information for an efficient interpretation of the classification results. The software also offers the young scientists the possibility to get different standard indices to explore the vitality of the vegetation, such as the NDVI. Moreover, it will be possible to evaluate the classified image and publish it with several standard layout elements, like title, scale and legend.

There are numerous situations in which it is useful to work with this software in school. It can obviously be used in a geographical context, but also in environmental science, mathematics, information technologies and in exercises which combine the mentioned or additional subjects.

There are lots of relevant themes, like desertification, the development of cities, the agricultural and industrial land use or the exploration of natural resources (Albertz, 2007, Jürgens, 2003, Hasenpflug, 1998). The main goal of working with satellite images is to encourage and motivate pupils to solve a geographical or environmental science problem on their own, while they are acting independently and feeling useful and important (Gudjons, 2008, Klafki, 2007).

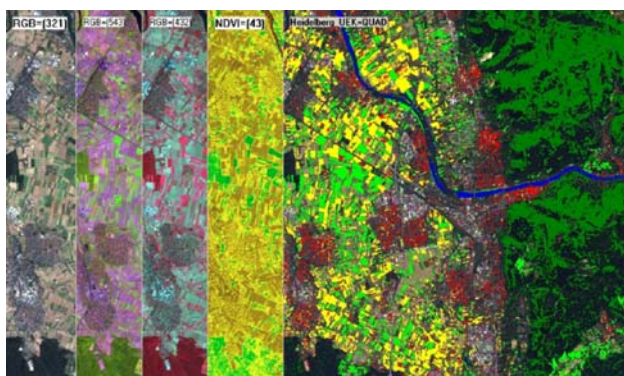


Figure 6: Choices of some technical features: True-colour-composition (RGB 321), false-colour-composition (RGB 543/432), NDVI (43) and supervised classification (based on Landsat images from Heidelberg/Germany)

To support the software, the teachers and pupils will find a tutorial and a selection of representative exercises which will give the students and teachers' helpful hints on using the software and interpreting the results. The development and testing of this web based software is still in progress. It will be available to all schools free of charge from summer 2010 on.

5. CONCLUSIONS

The implementation of remote sensing in class should become more regular and widespread – more than the actual situation where only some teachers are using satellite images or even software to analyze remote sensing data. As shown in this paper there are different ways to implement remote sensing in school, depending on the students' age and knowledge. A first but main result of all the projects, which are still not finished, could be summarized in the cognition that remote sensing should be used as a geographical tool, like an atlas or a globe. The potentials of satellite images or aerial photos are immense, much more than a simple map of a region. So working with remote sensing data on a subject like the tropical rain forest includes a lot more information on e.g. the actual dimension and its vitality. To develop age-based content materials and software for different subjects using satellite data as tools seemed to be the important step in a concept to promote the implementation of remote sensing in school.

REFERENCES

- ALBERTZ, J., 2007. *Einführung in die Fernerkundung. Grundlagen der Interpretation von Luft und Satellitenbildern*. Darmstadt.
- BRUCKER, A. 2006. *Luft- und Satellitenbilder*. In: Haubrich, H. (Ed). *Geographie unterrichten lernen. Die neue Didaktik der Geographie konkret*. München, pp.178-179.
- DGfG 2008. *Bildungsstandards im Fach Geographie für den Mittleren Schulabschluss – mit Aufgabenbeispielen*. Berlin.
- GERBER, W & REUSCHENBACH, M. 2005. Fernerkundung im Unterricht: *Geographie heute* (235), 11/2005.
- GERMAN UNESCO COMMISSION 2009. *Ziele der Bildung für nachhaltige Entwicklung*. <http://www.unesco.de/2192.html?&L=0> (04/06/2009).

GUDJONS, H., 2008. *Pädagogisches Grundwissen: Überblick - Kompendium – Studienbuch*, Bad Heilbrunn.

HIEBER, U. & LENZ, T., 2007. Bilder lesen lernen. *Geographie heute*, 28 (253), pp. 2-11.

JÜRGENS, C., 2003. *Geo-Fernerkundung- was ist das?* Praxis Geographie, 3/2003, pp.4-7.

KLAFKI, W., 2007. *Neue Studien zur Bildungstheorie und Didaktik: Zeitgemäße Allgemeinbildung und kritisch-konstruktive Didaktik*, Weinheim.

KOLLAR, I., SIEGMUND, A. & SIEGMUND, A., 2008. Future ways of learning through remote sensing in school. In: DONERT, K., & WALL, G., (Eds.). *Future Prospects in Geography. HERODOT Conference Proceedings*, 4-7th September 2008, Liverpool Hope University, pp. 431-438.

NAUMANN, S., SIEGMUND, A., DITTER, R., HASPEL, M., KOLLAR I. & SIEGMUND A., 2009. Satellitenbilder in der Schule – von der Theorie zur praktischen Anwendung, In: SEYFERT, H. (Ed.). *DGPF- Jahrestagung*, Jena 2009, Vol. 18, pp. 41-50.

ROSEEU, R., 2004. Digitale Satellitenbilder; In: SCHLEICHER, Y., (Ed.). *Computer, Internet & Co. im Erdkunde-Unterricht*, Berlin.

SIEGMUND, A. & WOLF, A., 2006. Satellitenbilder im Unterricht – eine internationale Vergleichsstudie zum schulischen Fernerkundungseinsatz. In: MICHEL, U., & BEHNCKE, K., (Ed.): *Veröffentlichungen des AK Fernerkundung* 2006, Osnabrück, pp. 137-148.

SIEGMUND, A., & MENZ, G., 2005. Fernes nah gebracht – Satelliten- und Luftbildeinsatz zur Analyse von Umweltveränderungen im Geographieunterricht. In: *Geographie & Schule*, 27. Jg., H. 154, pp. 2-10.

THAMM, H. P., & JUDEX, M., (2005). Einsatz einer kleinen Drohne für hochaufgelöste Fernerkundung. In: STROBL, J., BLASCHKE, T. & GRIESEBNER, G. (2005). *Angewandte Geoinformatik, Beiträge zum 17. AGIT-Symposium Salzburg*, Huthig, Heidelberg, pp. 722-730.

VOß, K., GOETZKE, R., & THIERFELDT, F., 2007. Integration von Fernerkundung im Schulunterricht. In: SEYFERT, H. (Ed.), *DGPF- Jahrestagung*, Basel 2007, Vol. 16, pp. 41-50.

WOLF, A., KOLLAR, I., SIEGMUND, A., 2008. Faszination Fernerkundung: Satellitenbildeinsatz im Unterricht. In: *Praxis Geographie* 04/2008, pp. 44-46.

WOLF, A., & SIEGMUND, A., 2007. The Earth from Above – An International Study on Remote Sensing in Modern School Geography. Challenges and Possibilities. In: CATLING, S., & TAYLOR, L., (Eds.). *Changing Geographies: Innovative Curricula*. Oxford, pp. 363-368.

ACKNOWLEDGEMENTS

The authors would like to thank Kathrin Viehrig for English corrections. This work has been supported by the Deutsche Bundesstiftung für Umwelt (DBU, Glokal Change, AZ: 24439-43/0) and the Klaus Tschira Stiftung gGmbH (BLIF).