FROM HYBRID COURSES TO BLENDED LEARNING: A CASE STUDY

Hans Hinterberger, Lukas Fässler, Bettina Bauer-Messmer
ETH Zürich, Institute of Computational Science, CH-8092 Zurich, Switzerland

KEYWORDS: Blended learning, e-learning, application oriented learning, constructivism

Abstract: To accommodate large classes and raise the motivation of natural science students taking an introductory information and communication technology course, we introduced e-learning material. An analysis of the factors that contribute to the course's success shows that it is not the application of technology in various forms that is responsible but the careful blending of different didactical methods, based on sound pedagogical principles. After we started using e-learning material based on active, application oriented, individualized learning, we noticed a remarkable increase in the student's motivation. They can apply conceptual knowledge more flexibly and work more independently with increasing self confidence.

1. INTRODUCTION

Already before the development of the World Wide Web and the e-learning-wave that followed in its wake, complaints were voiced that students have acquired extensive theoretical knowledge but that they cannot use this knowledge outside of school or university (Reimann-Rothmeier 1996). In other words, the acquired knowledge remains inactive. This deficiency cannot be repaired with electronic learning environments alone, no matter how ingenious they are, it is above all a pedagogical question of how to effectively transfer information.

In this context we are interested in didactical methods that focus on result oriented learning. Bloom provides a useful scaffolding with his taxonomy of educational goals (Bloom, 1956), dividing cognitive training goals into six classes (K1 - K6): *knowledge*, *understanding*, *application*, *analysis*, *synthesis* and *evaluation*. This taxonomy helps us guide our instructional efforts towards clearly defined goals that describe different levels of a student's competency.

In traditional scenarios of introductory instruction, learners typically reach levels K1 and K2, an indication that knowledge will remain inactive. They are exposed to extended passiveness, learn superficially and without a long term view, while the lecturer aims to transfer a ready made "knowledge system". Many suggestions for reform (exploratory learning, constructionalism in various flavors) therefore rely essentially on active, application oriented learning, in order to reach competency levels K3 and higher through active involvement of the learner. Interestingly, assessments often include problems requiring K3 competencies or higher even though the corresponding instruction only trained for levels K1 and K2.

This paper reports experiences we made using e-learning with an introductory ICT course (Information and Communication Technology) and summarizes lessons learned.

The starting point

We decided to redesign the ICT course six years ago, with the following goals in mind: incorporate active, *application oriented learning*, teach *large classes* without sacrificing *individual support*, provide the means for *self controlled learning*, and investigate the potential of *e-learning* course material.

In a kind of tight rope walk the course's content has to challenge students already experienced with computers while it avoids overtaxing those who lack these skills. The large number of students forces us to apply didactical concepts which can provide a maximum of support – particularly for less experienced students – with limited personal resources.

The course *Einsatz von Informatikmitteln* (application of software tools, www.evim.ethz.ch) is compulsory for students enrolled in eight natural science programs. Approx. 300 students have the course scheduled in the winter semester and 350 in the summer. During this course, students must acquire not only conceptual knowledge but also ICT skills and gain the confidence to apply them. This last point is crucial if we expect that students continue to expand their ICT competencies.

The course is structured as follows. Theoretical principles of ICT and the "big picture" are covered with a weekly two hour lecture. The class discussions are complemented with lecture notes. Every two weeks the students are given a new set of exercises which were originally organized as printed tutorials, to be worked through at a student's own pace. The tutorials – on average about 15 pages long – guide a student step by step through a problem that he or she solves with a given software application (e.g. a database program). At the end of each tutorial, students are required to solve a different, but related problem independently and then demonstrate and explain the solution to a teaching assistant.

Each student must complete a total of six tutorials, covering the following topics: internet publishing, simulation with spreadsheets, visualizing multivariate data, managing data with spreadsheets, managing data with a relational database, and macro programming.

2. SUPPORTING ACTIVITIES WITH APPLICATION TUTORIALS

Most instructors, faced with the redesign of a course with large classes, will today seriously consider using electronic media. In many cases this does perhaps solve the problem of *quantity*. There exists, however, this stubborn *qualitative* problem of the inactive knowledge.

Trusting in application oriented learning to attack this problem we created written tutorials to guide students through six conceptually different application programs while solving a well defined task. At the center of this effort is the problem solving process, not the operation of the software.

Each ICT application has its own tutorial which is organized into three parts as follows. First, an introductory part gives a brief overview of the abstract concepts relevant for the application and introduces the important terms – complementary to the lecture, in which the corresponding theory is treated at a more general level. At this stage we relate ICT topics with the (potentially) future scientific activities of the natural science students. The theoretical introduction is supported with a glossary that contains the applicable technical ICT terms. These documents span the student's learning space and give it a supporting structure.

In the second part, students are given a series of tasks, each of which has been broken down into a collection of small instructions, leading directly to practical activity. Perhaps the most challenging detail has been to find a way to "package" concepts into a set of instructions which lead to activities that allow a student to *construct* his or her knowledge (a method known as *constructivism*), rather than just memorize it.

The third part deals with assessment. A student is tested with a problem that he or she should be able to solve *independently*, with the knowledge and the skills learned while working through the tutorial. As a feedback to the student, this test certifies her or his competency in a particular ICT application. At this stage the students interact with the teaching assistants, whose task is to verify authorship of the results and confirm that concept and theory have been correctly understood and been applied in the right context.

Teaching assistants not only accept excercices in the computer rooms, it is also their duty to be present at fixed times to provide support with the tutorials, should the need arise.

Active, application oriented learning motivates

After we started using the tutorials, we noticed a remarkable increase in the student's motivation. They are able to apply conceptual knowledge more flexibly, they work more independently with increasing self confidence and, whenever they consult teaching assistants, they do so primarily for problems relating to the application in the context of analysis and synthesis (K3 - K5). Course evaluations show that over 90% of the students react favorably to these tutorials. This positive qualitative shift in educational effort is possible because students are provided with material that allows them to learn elementary skills completely on their own as active learners. With over 300 students per semester, this gain in efficiency pays off.
Some of the natural science programs require their students to pass an introductory programming course. Because programming requires other skills and competencies than using standard ICT applications, we are currently adapting the design of the tutorials conceptually and technically to meet these new requirements.

3. HYBRID COURSES: ATTACHING E-LEARNING TO TRADITIONAL COURSES

Tutorials are prime candidates for e-learning because, when guiding people through a software application with written instructions, it stands to reason that the instructions themselves are presented on the same computer screen and furthermore include self-control elements. We started to develop hypertext-based tutorials in the summer of 2000, supported by a research grant of ETH (Fonds Filep) and called the software *application guides* (see center of Fig.1).
The didactical concept of the course remained unchanged, only the application guides were to be available on the web. In hindsight we call this approach a *hybrid course*: adding a new technology to instruction which allows the paperless delivery of a tutorial. The following summarizes the experiences we made with these and other ideas that came up while developing and using these electronic application tutorials.

Electronic textbook

Once we decided to use hypertext documents, it seemed a logical extension to also create an electronic version of the lecture notes and link its content with the tutorial and the glossary. We learned, however, that availability of information in itself is not a major problem when instructing. Linked hypertext pages and text databases with search facilities simply provide novel access but they do not reduce the complexity or the abundance of information.
Our experience shows that with an application-oriented approach, the theory, necessary for a given concept, can be broken up into doses with a depth that will allow students to construct an understanding while working through a concrete problem. The information, presented in detail in a textbook is too remote from the information students require to solve their immediate pactical problems. Theory must therefore be reworked into smaller units that relate to a concrete problem.

Animations, videos

To visually support the step by step instructions of the application guide, we first experimented with short video sequences. We realized, however, that animations and videos are instructor-centered and do not support the student's activity.

As soon as students themselves can control their learning process, animations and videos are no longer consulted. We observed that illustrations, which depict way points to be passed on the road to competency (intermediate results), have proven to be more effective.

In other words, students do not want to watch a moving mouse pointer, they want to take the mouse into their own hand, because they are expected in the end to solve a problem by themselves.

Teaching assistance

The presence of teaching assistants during fixed hours allows students to build up a relationship with a real room and real persons. The role of the teaching assistant, however, has changed from information broker and example problem solver to coach (answering detailed questions, controlling learning progress, providing feedback).

This also animates students to more frequently help each other out, finding answers to many small questions by themselves, thus making other mechanisms to support collaborative work superfluous.

Time management

In general, students spend more time with our e-learning material, are more motivated and work less superficial than they did with traditional methods. They do not save time during the semester, however, because they deal intensively with material which before they used to work through just prior to the exams.

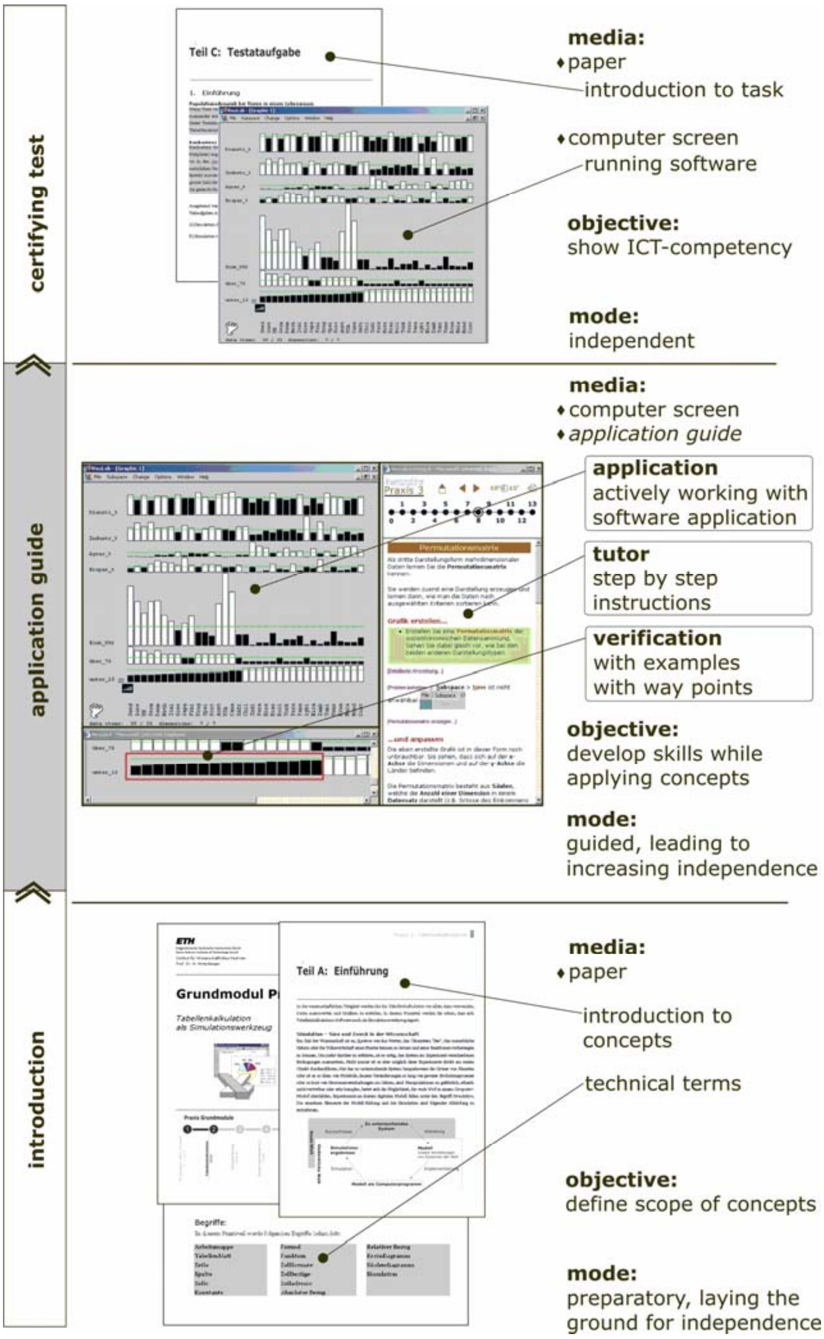

Figure 1. *The structure of an application oriented tutorial. Concepts combined with skills for different software applications lead to independent ICT-competencies. The interface to the application guides consists of three windows: one running an application, another with instructions to guide users through an exercise, a third in which expected outcomes or supportive information can be displayed. The paper-based introduction to concepts and technical terms spans the space of the learning process.*

Saving time should not be an important pedagogical goal in our opinion anyway; but to better distribute activities such that time can be effectively utilized should be.

Media

The only e-learning material we provide are conceptually well structured instructions (application guides) that not only lead to certain skills but through subtle integration of theory lead to ICT-competencies. To work with the application guides, which can be called up on the web, one only needs a browser. The e-learning material is also available on a CD-ROM for those who cannot or want not spend time on the internet. Interestingly, given the choice, most students prefer the CD-ROM over the web (even when they have free internet access in the schools computer rooms). Virtuality is hard to sell.

Quality control

The course's acceptance is evaluated regularly with questionaires which include the lecture, the tutorials and the assessment, because only then can students judge their learning progress accurately (see: http://www.evim.ethz.ch/appliguide/evim_evaluation.htm). The course's effectiveness is evaluated with an application-oriented test at the end of the semester. These output-oriented assessments provide us with a realistic estimate of what students actually learned in our course.

The most useful feedback to control the course's quality results from the 10 minute verbal assessment session at the end of each tutorial during which students explain to a teaching assistant how they solved the tutorial's final problem. These assessments show that students are not only more motivated, they also learn more. As part of its redesign, the observable output has become the dominant quality criterion.

The course's quality has also been confirmed indirectly through the fact that students were spontaneously asking for application guides in the programming courses that followed and showed disappointment when told that they have make do without them.

Assessment

To certify a student's competencies, we introduced verbal assessments for each tutorial. The assistant's feedback becomes a reward for a student's efforts that counts much more than the credit points at the end of the semester.

Our students must also pass a one hour exam at the end of the course. With traditional courses, students are often required to solve application oriented problems during an exam even though instruction seldom passed beyond K2. The resulting failure rates often tempt the instructor to fix averages by adjusting the grading scale accordingly. Application oriented learning makes it possible to raise the questions of an exam to levels K3 and higher, reducing this side effect. We have become convinced that if instruction and assessment are to be effective, both must be designed for the same cognitive level.

A future project will examine methods to electronically administer exams with individualized tests that include application oriented questions. The underlying database of questions will also be accessed during the course, allowing a close coupling of instruction with assessment so that students can verify their progress and become competent at the level of K3 and higher.

4. BLENDED LEARNING: STRATEGICALLY INCORPORATING E-LEARNING

The experiences described in Section 3 have led us beyond the simple change from paper-based to e-learning instruction. Several aspects of self-controlled learning made us unavoidably aware of the necessity to consider many didactical issues when introducing technology.

The term *blended learning* imposes itself to describe the pedagogical scenario necessary to extend the positive experiences made with the online tutorials to the entire lecture. An attempt at a definition of blended learning, as we understand it, might read as follows: *An instructor supports blended learning if he or she includes in the curriculum socially supported interaction (e.g. classroom instruction), self-controlled instruction (e.g. e-learning material), assessment as feedback to students and instructor, and applies to all of them the same instructional strategy to define the targeted competence level.*
This is in contrast with current definitions of the term, such as "with blended learning, instructional designers divide a learning program into modules and determine the best medium to deliver those modules", we call this modular learning. Or, "blended learning is a method of educating at a distance that uses technology, combined with traditional education", these we call hybrid courses. Blended learning, understood as a mix of old and new best practices in education has to be welcomed with the caveat that just mixing will not yield much of an improvemen, unless the right recipe has been found. Above all, it must support a learning style that leads to deeper and better knowledge acquisition.

Supporting different learning styles

Traditional methods of teaching typically produce two different learning styles: breadth-oriented and depth-oriented learners. Breadth-oriented learners primarily scan course content and concentrate on their capacity to memorize with the goal to reproduce knowledge at a later time. Depth-oriented types want to work the material over in a way that will lead him or her to a fundamental understanding of the subject matter. Breadth-oriented learners will often pass traditional assessments successfully, because many can concentrate on the essentials and their knowledge will often be judged to be more precise because they have a large body of technical terms at their disposal.
The depth-oriented type acquires a more sustainable strategy in dealing with a particular topic, however. These students generally know fewer terms, but they can better describe the context in which a term exists and are more proficient at problem solving (K3 and higher).
The application guides with their assessment strategy support depth-oriented learning. It can lead students to the insight that with such a strategy they become better problem solvers in the long term and will be better equipped for life long learning.

SUMMARY

The great potential of e-learning to deliver educational information can be profitably exploited if the underlying learning process leads to new skills and competencies. A careful combination of active applications, enriched with relevant concepts, can be successful if they are embedded in a blend whose elements (lecture, practice, and assessment) fit together. To this end, competency levels that apply to all of these elements must be defined.
With e-learning, individualized instruction is possible also in large, heterogeneous classes. As a rule, however, it does not reduce cost and time. But it can raise the quality of instruction and motivate students to learn longer and more profoundly and, as a consequence, it prepares them better for continued education.
Moving the problem solving procress instead of theory to the center, ideally supports constructivism and provides students with a structure that gives them the security to learn more effectively and expediently.

REFERENCES

BLOOM, B.S. (Ed). (1956). Taxonomy of Educational Objectives Handbook 1: Cognitive Domain. New York: Longman, Green & Co.

REIMANN-ROTHMEIER, G., MANDEL. H. (1996). Lernen auf der Basis des Konstruktivismus. Computer und Unterricht 23, 1996, 41-44.