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The Application Guide: Each Student His Own Tutor

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Abstract: Repeatedly, complaints are voiced that students have extensive theoretical knowledge but that they cannot use this knowledge outside of school or university, the acquired knowledge remains inactive. Attempts to repair this deficiency with electronic learning environments often fail, however, because the solution is, above all, a pedagogical one. The most promising efforts in this direction are based on active, application oriented learning. To show that this approach can be applied successfully with e-learning, we have developed, used and evaluated so called application guides to teach different ICT topics. The interface to the application guides consists of three windows which, in combination, allow students to gain insight while interactively working through a concrete problem. Using application guides in a blended learning environment has led to a remarkable increase in the students' motivation. They are able to apply conceptual knowledge more flexibly; they work more independently and with increasing self confidence.

Introduction

Its ability to make large quantities of digital information available for learning and instruction anytime and anywhere has made the Internet a revolutionary influence on the use of computers in education. Education, however, comprises more than information. Pedagogical insights tell us that practical application and other means to integrate what has been learned are essential to achieve sustainable learning. Easy access to information often seems to be coupled with the risk that information is confused with insight and understanding. The challenge for computer-assisted instruction therefore is to not simply present information fascinatingly but to allow for an interactive and stimulating learning.

The Pitfall of Inactive Knowledge

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. 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. A useful scaffolding is provided by Bloom's taxonomy of educational goals (Bloom et al. 1956) which divides the cognitive training goals into six classes (K1 - K6): *knowledge*, *understanding*, *application*, *analysis*, *synthesis* and *evaluation*. With this taxonomy we can 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 goals on the levels K1 and K2, an indication that knowledge remains 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.

Application Oriented Learning

With the introductory computer science course for natural science students at ETH Zurich we have shown that active, application oriented learning can also be applied successfully with e-learning. The Department of Computer Science at ETH Zurich, like other departments also, faces the challenging task to offer introductory Computer Science courses as a minor subject in other programs. We consider them a challenge, because virtually all successful scientific activities require various competencies in information and communication technology (ICT), a fact that freshmen typically have not had the chance to appreciate. Large classes, different levels of prior knowledge and ambivalent attitudes towards ICT aggravate the situation, requiring additional efforts to teach these classes. For these reasons it is important that computer science, as a service lecture, is embedded in meaningful practical applications and that it allows self controlled learning.

Applications: an Ideal Basis for Self Tutoring

During the past 3 years we have developed, used and evaluated so called *application guides* to teach 6 different ICT topics: internet publishing, simulation with spreadsheets, visualizing multivariate data, managing data with spreadsheets, managing data with a relational database, and macro programming (see: http://www.evim.ethz.ch/appliguide/3_visulab_engl for an English version of an application guide). Application guides are successfully used to supplement the traditional lecture with computer supported training aids in a blended learning environment. Each ICT application is organized into three parts as follows (for details see Fig. 1):

First, an introductory part gives a brief overview of the abstract concepts relevant for the application and introduces the important terms. At this stage we relate ICT topics with the (potentially) future scientific activities of the natural science students. These documents span the student's learning space and give it a supporting structure.

In the second part, students work through the application guide, which guides 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 center is the problem solving process, not the operation of the software. In one of the three windows students were given a series of tasks, leading to practical activities in the second window, where the software application is running. The third window serves as a self control element. 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, rather then just memorize it. Working through an application guide can require anywhere from 2 to 5 hours; students therefore highly appreciate the flexibility they enjoy while working through an application guide over the web or off CD-ROM.

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.

Active, Application Oriented Learning Motivates

After we started using the application guides, we immediately 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 favourably to the application guides (for details see: http://www.evim.ethz.ch/appliguide/evim_evalutaion.htm). 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 300 students per semester, this gain in efficiency really pays off. This individualized instruction 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.

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 application guides conceptually and technically to meet these new requirements. Starting in the fall of 2004 we will examine in class how the methods and techniques of the application guides can be applied to teach programming in a blended environment.

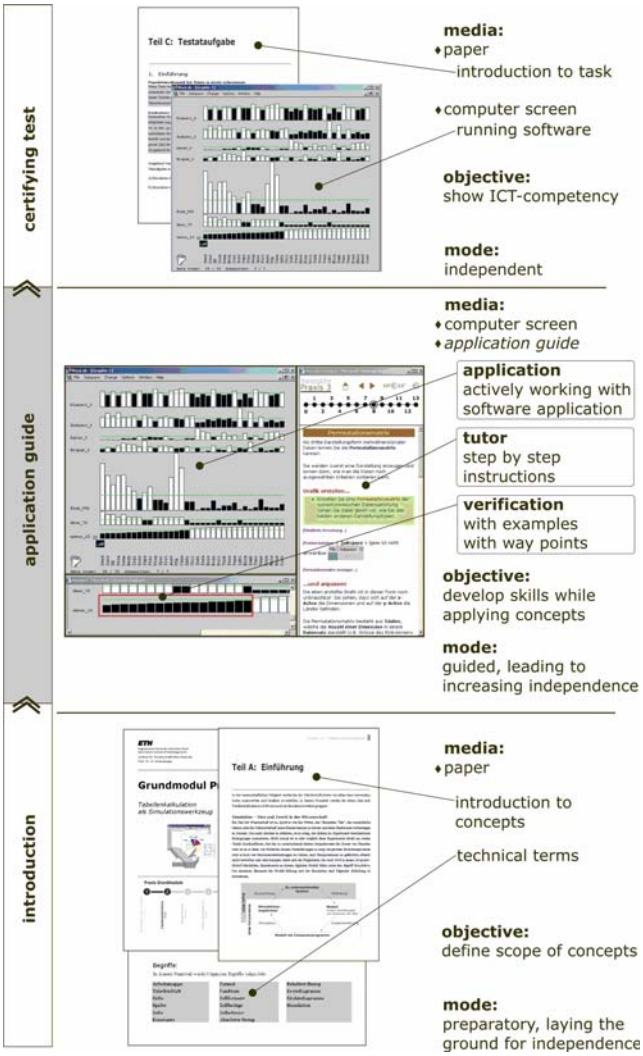

Figure 1: The structure of an application oriented tutorial. Concepts, combined with skills for different software applications, lead to independent ICT-competencies. The interface to the application guides consists of three windows: one running an application, another with instructions to guide users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

References

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