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**TEACHING MATHEMATICS OVER THE WEB
- TOOLS AND CONTENT,
POTENTIALITIES AND DIFFICULTIES - ***

In the years 2001 through to 2003, the German Ministry for Education and Research (BMBF) sponsored the so-called 'Zukunftsinvestitionsprogramm' (future investment program). It was devoted to the introduction of new media into university teaching. For a survey we refer the interested reader to [5].

One of these projects was math-kit. It brought together partners from universities in Hagen, Bayreuth, Paderborn and Hamburg. The aim was to investigate the use of multimedia in undergraduate mathematics. In the course of time, a construction kit was developed that provides various multimedia elements for exploration and visualization as well as drills, exercises and applications (cf. [3], [4] and [6]). Since evaluation played a major role throughout the whole project, the following report will mainly be given from that point of view.

Multimedia elements

As mentioned before, most elements from math-kit are small stand-alone units, providing support for special topics from undergraduate mathematics. Many of them were applets programmed in Java. Besides those built from scratch, the dynamic mathematics software GEONExT [8] proved useful to ease the production of such elements. Whenever more elaborate computing power was required, the computer algebra system MuPAD was available. It can be approached via a web server, thus avoiding the necessity to install the software on every computer where it is used. Finally, some of the multimedia units have been integrated into dynamic learning environments based on constructivist educational models like I – you – we and refinements of it using e.g. problem solving strategies [1].

Distance education

Traditionally, distance education is based on the dispatch of printed study material. Starting, with the winter term 2002 / 03, in a course on Linear Algebra at the Distance University in Hagen (Germany) this procedure has been extended by the use of internet and multimedia. In particular, additional material and multimedia elements offering interactivity have been integrated into the course.

Evaluation

Just as didactical considerations, evaluation was permanently accompanying the progress of the project. There were three main aspects:

- Testing elements: It is considered standard that multimedia elements have to be tested both before release as well as when deployed.
- Beginners' questionnaire: In order to obtain a user's profile, printed questionnaires were distributed among beginners' students of subjects like mathematics but also engineering, chemistry and pre-service teachers for all kind of schools. As a result, it was possible to state a broad common basis of given prerequisites among all these intended users. In particular, some acquaintance with computer and Internet as well as a certain motivation to deal with mathematics can be assumed.
- Formative evaluation: Much effort was spent on a formative evaluation of the distance education course on Linear Algebra which was described above. The main component consisted of online questionnaires coming along with each multimedia unit offered via Internet. Furthermore, spontaneous feedback was possible by email or newsgroup. And finally, during onsite events (twice a semester), questionnaires and interview helped to round up the evaluation.

Results

To sum up, one has to state a lot of technical problems, especially in the initial phase. These ceased prevailing after some time, giving way to concentrate more on aspects of content. Due to the duration of the project so far, no long-term statements can be made (e.g. concerning sustainability). However, some positive trends can be observed. Let us go a little bit more into details (cf. [2]):

- Form of the material: There still is a big preference for printed material.

- Internet access: Though the numbers constantly are increasing, not every student has free access to the Internet at the time wanted. Moreover, even if there is access, the technical framework may set severe limits to the online use of multimedia elements (considering e.g. download times).

- Heterogeneous and insufficient computer configuration: In the situation of distance education, every student has an-other computer configuration, which varies very much and from time to time does not meet the minimum requirements for the use of online materials.

- Lack of computer literacy: Contrary to the students' self-esteem in the beginners' questionnaire, a lack of computer literacy became evident to quite a large extent. This affected various aspects like the appropriate handling of different file formats or the efficient navigation through the Internet. In the end, this deficiency may be ascribed to the multimedia material and thus possibly lead to a loss of motivation.

- Increased students' activity. Despite all those drawbacks, there are several indications of an increased students' activity which justifiably can be imputed to the use of multimedia in distance education. Among them are a lower dropout rate, more frequent newsgroup activities and an increased motivation expressed by the students.

Conclusions

Of course, our reaction aimed at keeping the positive effects and reducing the negative ones. It is obvious from the points discussed above, that technological aspects have to be taken special care of as well as the students' skills with respect to the use of computer and internet. Let us mention two actions we took with that respect: A CD-ROM with standard software was distributed among the students at the beginning of the next term. Furthermore, the students awareness of required skills with regard to computer and Internet was fostered e.g. by a booklet containing relevant information.

As a final remark we would like to point out, that the students definitely benefited from the increased effort we made in preparing and accompanying this course of linear algebra. This required an increased expenditure in time and manpower. Though materials once produced can be reused, they still have to be updated (both with respect to technology as

well as content). Hence, multimedia will not diminish costs to zero. On the other hand, an appropriate use of multimedia can surely enrich university education and improve the process of learning and teaching.

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Internet addresses

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- [8] the GEONExT Internet site: <http://geonext.de>

* Стиль та орфографію автора збережено