

Databases Improve Technical Studies

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Target

In Lower Saxony, technology studies as part of preparing technical education teachers for primary and partly for secondary education can be studied only at two universities—the Technical University of Brunswick and the University of Oldenburg. Technology education is not available at the Gymnasium (a type of secondary school leading to the university) in Lower Saxony.

Universities in Lower Saxony and other German states have agreed about the basic contents of technology education that should be taught in the public schools. However, the themes are emphasized differently, because the universities view the subject and conduct their research differently from one another.

The target is to connect the technical resources of the participant universities to reveal the variety of contents of the subject and to allow access to sources of knowledge irrespective of time and place. Specifically, the creation of accessible databases for technology education via the Internet will help educators teach technology as thoroughly as possible and offer the opportunity to reach larger numbers of students at colleges and universities. A further step will be to connect the databases of individual partner universities to a database network.

The technology education database is meant to represent an important scientific and didactic source for the subject *technology*. Our further intention is to include the latest results of research, including that gained from national and international technical learning processes, and to maintain teachers' educational experiences in the form of evaluated teaching samples. We plan to include proven samples of lessons that have been tested by teachers, lecturers, and students as "methodical patterns" that can be used subsequently by other students and lecturers.

The technology education database will help students to fulfill the following tasks during their studies (Dick, 2000; Scheuermann, Schwab, & Augenstein 1998):

- Acquire and select specific information for special themes.

- Prepare papers and work on scientific reports.
- Prepare and rework lectures.
- Study the contents of technology education irrespective of the place of studies and the type of school.
- Study as independently as possible.

Lecturers will get support to fulfill their educational tasks:

- Compile and work with technical literature.
- Select adequate educational material, either discrete (texts, pictures) or continuous (video, audio, simulations, animations).

Advantages of the Technology Education Database

The technology education database has several advantages. It will:

- Create a source of knowledge concerning technology education at universities and public schools.
- Ensure efficient presentation of the interdisciplinary structure and the variety of contents of the subject and its various media and methods.
- Have flexible application of the database's modules (applicable in a new context, adjustment of contents, application regardless of time).
- Allow students and lecturers to have access to the database via the Internet irrespective of time and place to plan studies independently or to prepare lectures.
- Enable national and international exchange of knowledge and experience between universities.
- Promote self-learning.
- Develop competence with regard to media and information.
- Awaken the interest of females in technology education by offering easy access to knowledge.
- Enable worldwide distribution of educational material.
- Facilitate students' transfers between institutions not only within one federal state but all over Germany, as certificates

are mutually accepted.

- Facilitate installation of a course of study for Europe or overseas (medium-term and long-term plans).

Contents of the Technology Education Database

The contents of the technology education database are closely related to the courses of study of the university. Although courses of study differ from university to university, the fields of study are identical in most cases. The content of the fields of study is focused on technological processes and systems that are categorized by material, energy, and information.

The courses of study include not only special scientific fields, but also special didactic fields that students must study. Usually the contents are taught in the form of lectures, seminars, exercises, and practical training in laboratories and workshops. As a target of the database network, the fields of study will be enhanced by the multimedia teaching and learning modules of the technology education database.

If it is possible to update lectures and to give them a personal note, then the content will have to be split into modules. The modules can then be used in different types of lectures and can be combined and completed in such a way that they meet the requirements of the individual courses of study.

The fields of study for the database must be selected. The modules have to be of special importance for the studies and, therefore, for the future professional work of a technology teacher. Thus, the modules to be developed should have a key function and students must master them through examinations.

In the first phase of this database network development, the University of Essen and the Universities of Brunswick and Oldenburg will create databases in their special fields. The Institute for Technology and Technical Didactics of the University of Essen plans to create modules for the following fields of study: materials science, energy technology, measurement, open-loop control, closed-loop control, and environment protection. The Department of Technology Pedagogics of the Technical University of Brunswick and the Institute for Technology Education of the University of Oldenburg intend

to create modules for the following fields of study: manufacturing engineering, information and communication technology, and didactics of the subject technology.

In Essen as well as in Brunswick the first modules and experiences already exist. The Institute for Technology and Technical Didactics of the University of Essen has created the first modules during a project, Component-Based Learning Software for the Training of Teachers, sponsored by the federal state of Nordrhein-Westfalen (<http://it.tud.uni-essen.de>). During the summer semester 2000, the Department of Technology Pedagogics of the University of Brunswick tested the application of an Internet module, Creation and Application of Websites for Learning Processes.

The modules may include exercises, examples of lectures, complete training programs, and single components. They are categorized and stored according to criteria that are important to the courses of study. Texts, graphics, animations, and videos as well as simulations, virtual tests, virtual laboratories, and case studies will be included in the modules. The possibility of authentically presenting complex technological/scientific matters is a project target that can be reached with the help of multimedia visualization.

One example is an ActiveX-Component, showing the characteristic of a feedback control unit based on an operational amplifier, which serves as a laboratory test. Video clips are intended to be used for the visualization of manufacturing processes to support the practical part of the studies (Schweres, Redeker, Theuerkauf, Balzer, & Rummel 1998). Videos will also be used for case studies that evaluate technology.

The individual databases of the network are being developed so that the contents of each are complementary. This process will take a longer period of time. The databases located at the universities will be dynamic. They require ongoing maintenance to remain current and thus require a new form of cooperation between the partner universities.

Practical Realization

It must be ensured that the database is accessible at any time and from any place. To meet these requirements, the modules and the

components of the database will be accessible via the Internet using Netscape or Internet Explorer. However, a prerequisite for this is that the didactically shaped modules are prepared in such a way to allow Internet capability.

Thus, new and existing knowledge must be structured, shaped, and transformed with respect to the rules of multimedia learning environments. This means that they have to be transformed into Internet formats (HTML, ActiveX, Java, JavaScript, etc.). This requirement is also necessary for the components of the individual modules. Texts must be formatted as xxx.pdf/rtf, graphics/pictures as xxx.jpg/gif/png, and videos as yy.mpg.

All files will be stored with their source code and documentation in databases running on Web servers of the universities.

As an example, the database will be installed on the computing center's dataserver of the Technical University of Brunswick. For this purpose, a determined storage capacity with defined access authority is at the user's disposal.

Learning Arrangement

With the database, lecturers have a source of the most up-to-date scientific and didactic contents including an address collection of Internet sources that enables them to use new methods for teaching. The components and modules can be used by the lecturer to demonstrate technological matters in lectures/exercises/tutorials. The lecturers can organize their courses without restrictions concerning contents and methods. The modules, which are independent concerning the contents and which can be combined variably, represent a source of information for courses, exercises, and projects.

However, technological processes, systems, and virtual laboratories can be visualized more authentically with simulations than with conventional media (Fäßler, 2000). Knowledge about the relationship of technological processes and systems can be obtained with the help of simulations.

With the database's contents structured according to didactical aspects, students can acquire information for a chosen or given theme for an exercise, a laboratory test, a task, or a project. As an example, components of the database can be included in one's own work.

The acquisition and evaluation of information will get more and more important, particularly regarding technical competence.

The database supports independent study, so that the themes of the courses can be expanded and completed. At the same time, students achieve media competence with respect to selection and evaluation of information as well as with the creation of new or improved modules during seminars or exams. Afterwards, these modules can be stored into the database, too. A module that helps to create Web sites will be the basis to transform teaching and learning methods so that it can be used on the Internet.

Partners of the Database Network

Internet-based studies and further education courses already exist on national and international levels. Designing the database without restrictions calls upon us to use experiences and developments of the special fields of other universities that are involved in the courses of study for technology educators and that also use multimedia in teaching.

Partners for this project among the federal states of Germany are the Department of Technology Pedagogics of the Institute for Scientific Didactics of the Technical University of Brunswick and the Institute for Technology Education of the University of Oldenburg. Other partners of the database network are the Institute for Technology and Technical Didactics of the University of Essen and the Institute for Technology and their Didactics of the University of Dortmund, which is responsible for the subject technology in secondary schools. The Institute for Vocational Education of the University of Rostock, which trains teachers for electrical engineering at vocational colleges, has announced its partnership, too. These partners ensure that in Germany the different courses of study for technology education in primary and secondary schools and in vocational schools are represented appropriately.

Due to the international interest in an exchange of training modules, a continuation project to enlarge the database network will follow in cooperation with partners, such as the University of Marseille, the University of London, and the Chilean Ministry of Culture. This database network can be seen as an important global source and as a forum for technology education. This step seems to be reasonable to

internationalize the course of studies for technology education as it exists in other nations, too.

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