

PRO-TEACH-NET AN E-LEARNING PLATFORM FOR PRODUCT DEVELOPMENT

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Abstract

New media in education is a key word, which is used by schools, universities, and by the Federal Ministry for Research as a way for a more effective procurement of knowledge. These new technologies and the change to an information and communication community constantly change education contents in the area of product development as well as the requirements to knowledge transfer by the lecturers. That again enables a change of classical training to dynamic training networks, which are carried by a holistic approach and an appropriate knowledge management [1]. Because of these considerations the project Pro-Teach-Net was formed. This project realises a cross-university training network platform for the education in product development and design. The main objective is the improvement of the quality of teaching. The project is a co-operation between five universities in Germany, all of which having different focuses. The different orientations and focal points of the individual institutes were bundled to a network and cover the entire spectrum of the education in product development and design.

The contents of the courses are derived from structures and contents of the lectures of the individual universities. The individual modules cover all education topics from design theory to special issues of CAx techniques. This paper describes procedures, strategies, and results, which were developed during the implementation of the platform.

Keywords: E-Learning, Education, Multimedia, WebCT

1. Multimedia in education

Computers and Internet are spreading further and thereby lead to a rapidly developing market for multimedia software systems. These are employed successfully in many areas of education and professional training. One goal of such systems is the improvement and the increase of the effectiveness of study and self-study and the supply of a platform for the mutual information exchange for the students. The systems offer new possibilities for the representation of images, animations, videos, and naturally texts. The application of these systems is not limited to the area of universities. Moreover, it is used in all school types, in professional as well as in off-the-job training. Multimedia systems offer a huge amount of technical possibilities to present learning content to the students in a new way.

The application of multimedia in the area of product development raises a number of questions, because areas like design theory, design methodology, mechanical components, drafting, CAx, and virtual product development are a very wide spectrum of knowledge to be obtained. Above all, the understanding of the connections between the different disciplines as well as the methods employed, represent a substantial educational aim.

2. Concepts of a multimedia based learning environment

The creation of a training network for product development should include as many areas of a specific subject as possible. Since education contents are not rigid and will change in even shorter periods, the learning environment must be easily adaptable to such changes [1]. So-called training modules allow a fast access to individual areas, whose content can be recombinated or exchanged. Thereby it is guaranteed that the learning platform can be maintained and updated with low effort even beyond the end of the running project.

Learning in the area of product development is always an action-oriented process [1], which is supported by design, computation, and computer exercises. That fact is not changed by the application of an Internet-based platform. Rather the way of teaching can be changed fundamentally by this medium. In the conventional education at German universities the content is presented orally in front of the students. The students are expected to take notes and fill up their knowledge gaps. Time for discussions or questions is only available in a limited scope, e.g. if only few students attend a lecture. In many other countries, students have to prepare for a topic, which is discussed and deepened during the lecture.

These very lectures and exercises will be supported by a suitable platform for self-studies. The students can prepare themselves for specific topics. The lectures will change to a discussion forum where special problems and examples are disputed and discussed with the lecturer based on the acquired basics. In addition, students can co-operate across their universities, exchange information, and attend the best lectures.

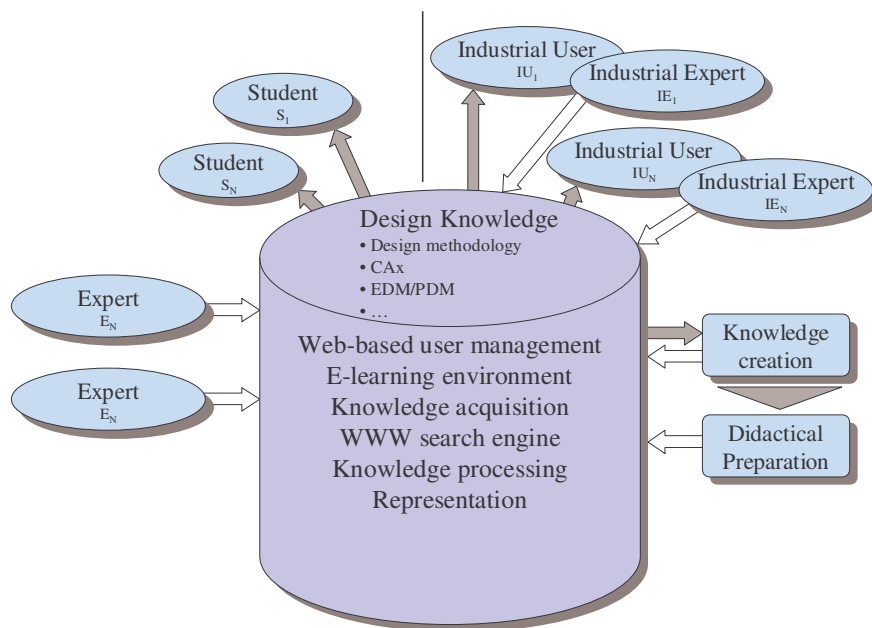


Figure 1. Concept of a multimedia based learning environment

The concept for the design as well as the use of an Internet-based platform is shown in **figure 1**. The knowledge base is filled by experts from universities and industry and is used by students as well as industrial users. For the lecturer it is important that the contents can be created easily and integrated into the platform as simply as possible. With a suitable platform, he also has access to other education materials, which he would like to use in his own course. In addition appropriate strategies and proceedings were developed, which enable the access to the material of each lecturer. Thus not only the knowledge of the experts of the individual institutions can be represented but also the knowledge of specialists from industry.

3. Contents of the multimedia based learning environment

The contents are essentially oriented at contents of the syllabi in product development and design. The basics are communicated within the modules A through E. In the modules F through H, special topics of the graduate studies are treated. Because of the different focuses of the involved universities a high quality of contents can be guaranteed. Not involved in the project are non mechanical topics like mechatronics or business studies. But additional courses can be created in the same way like the described modules.

3.1. Training modules for the undergraduate studies

The training modules A through D teach all engineering basics. **Figure 2** shows the structure of the training modules for the undergraduate studies, which was derived from the lectures of the individual institutions.

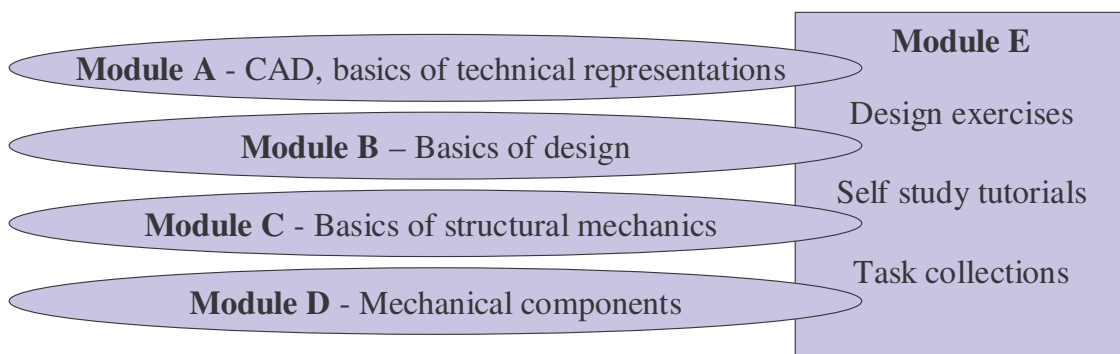


Figure 2. Modules of the basic study

- Module A contains the basics of technical representations and CAD. In this module, students get the general basics of the representation of technical objects as well as their computer-internal representation. Systems, system architectures, basic geometry, and product models are described.
- The module B covers the basics of design, fundamental proceedings and design guidelines. In detail, shape, function, environment, structure, and the principles of technical artefacts are stated.
- Basics of structural mechanics are treated in module C. Beside the aims and procedures for interpretation and computation of design features, interpretation and valuation criteria, strength calculation, conceptual procedures, and structural analysis are described as well.
- Module D deals with the topic of mechanical components. Sub-modules describe mechanical components such as bolts, springs, bearings, etc. as well as important technical procedures such as welding, soldering, and gluing.

The exercises and tasks connected to the modules A to D are summarised in module E. It deals with guides and tasks for self-studies and team work. The results can be exchanged with the lecturers via the platform. It contains exercises with automatic review, where the student receives an immediate feedback about the positive completing of a task.

3.2. Training modules for the graduate studies

The modules F through H cover the training areas in the graduate studies, **figure 3**.

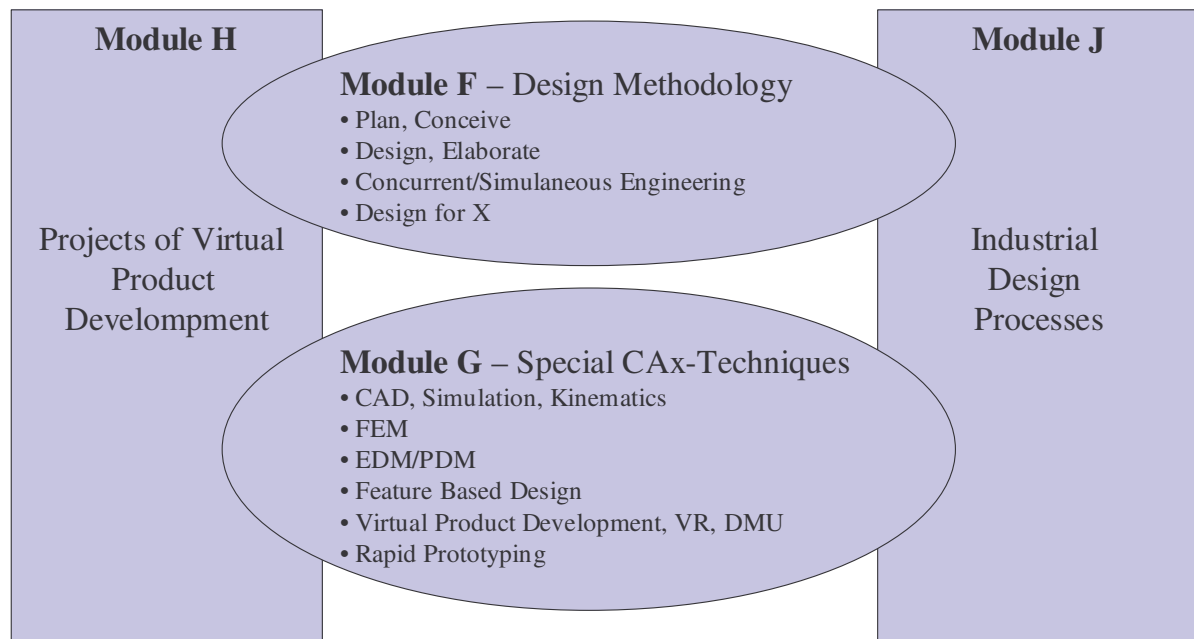


Figure 3. Modules of the main study

Module F covers the methodical basics of design, such as planning, sketching, Concurrent Engineering/ Simultaneous Engineering, and Design for X. In module G tools for the support of a methodical design process are described. Feature-based Design, FEM, EDM/PDM, Rapid Prototyping, and virtual product development belong to module G as well.

Accompanying the modules of the graduate studies, cross-university projects for virtual product development are to be done, which are performed in teams. These projects cover the entire bandwidth of the modules and should be an application of the theoretic education. Within such projects product developments are to be accomplished, whereby the teams at the different locations will work on subprojects and present an overall result at the end. The platform supplies tools for the exchange of data between the teams, but also between students and lecturers.

Module J is a collection of lectures and videos of representatives from industry. These will give the students and also lecturers an insight into the industrial practice. For the students a relation between the modules taught to their practical application is demonstrated.

4. Design of the multimedia based learning environment

A multimedia based learning environment offers a larger variety of presentation forms of the training subjects. This includes textual explanations, images, animations and interactive elements [2], [4]. In order to ensure a structured procedure during the implementation, a number of subtasks have to be executed. After the specification of the actual content and the definition of the training units (modules, sub-modules), the amount of content should be estimated and allocated to the individual project partners.

The functional range of the e-learning platforms is focused on the supply of services for the administration and structuring of instructional contents and the management of the course and its user.

The handling of the module content however is very costly if done with the tools of the learning platforms. For the creation and/or development of these content software tools exist, which better support these tasks. For instance texts and different kinds of graphics can be created with standard office software. Software tools can be programmed by using a software development environment; interactive elements or animations can be prepared with appropriate authoring software.

4.1. Creation of storyboards

Contents of an e-learning system are to be prepared in so-called storyboards. The storyboard serves both the description of the content (texts and diagrams) and the depiction of the process flow within the system (navigation). For a later interaction of the user with the system the interaction possibilities have to be defined.

The storyboard text may contain pure textual descriptions although rough sketches and drawings for visualisation are used as well. If the text of a page is shown successively block-by-block rather than as a whole, the appropriate text blocks must be marked. Multimedia elements, e.g. charts, diagrams or animations, can be sketched in the display area.

Due to its wide availability, the high diversity of the applied software tools and not least the large number of existing documents within the project Pro-Teach-Net, the storyboards were developed in Microsoft PowerPoint. An example of a converted storyboard side is shown in **figure 4**. For documentation purposes a status line was introduced, containing the processing status, the affiliation to a module, and the page number. The navigation for the user was realised on the basis of hyperlinks, which were arranged within the upper area of the storyboard. This navigation is intended to simplify the implementation into the e-learning platform. The lower area is used for the documentation of the status and editor.

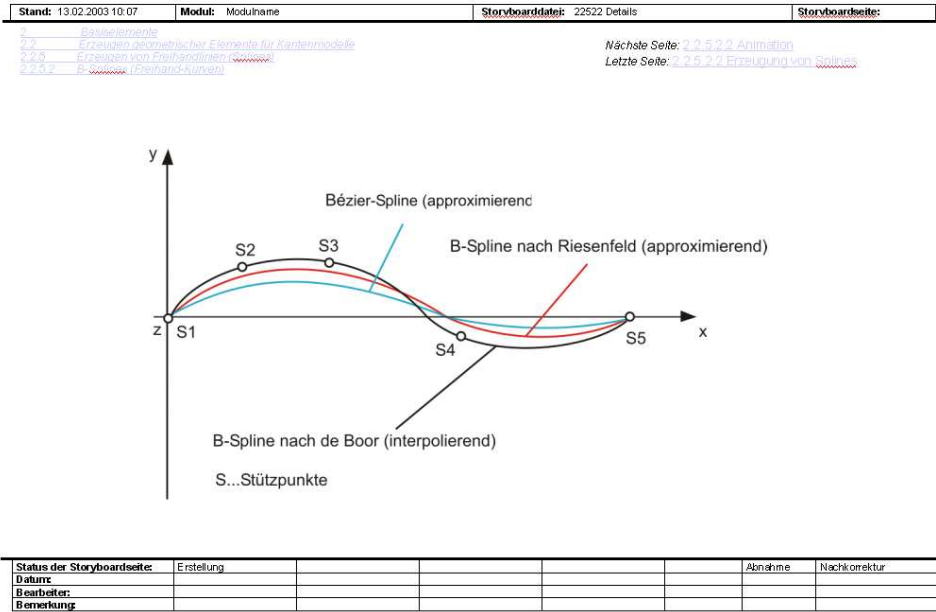


Figure 4. Example of a storyboard

The director's instructions and the flow diagram, which is partially represented in **figure 5**, are addressed to the development department of the screen design and programming. The storyboard author has the option to mark the currently available program functions within a page of teaching program. In addition, training objectives, which are to be achieved at this stage, can be defined. That is the hint that a test is to be accomplished.

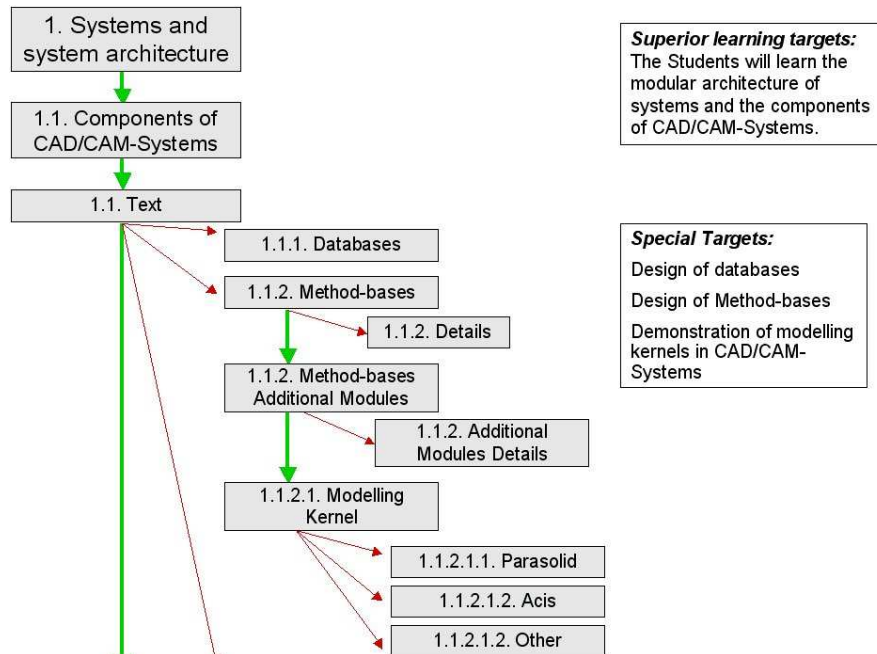


Figure 5. Definition of a flow diagram

4.2. Central administration of the storyboards and documents

In order to store the storyboards and all other documents and to make them accessible for all project partners, the project and document management system BSCW (Basic Support for Co-operative Work, <http://www.bscw.de>) was used. Even with projects distributed over several locations, BSCW is a good tool for an efficient co-operation of any size of user groups. The server is platform independent and easily available by web browser for each user. Each digitised information placed on the server by one of the project partners is permanently available for all other project partners. The BSCW server offers the access to documents and data of all project partners as well as an internal version management, access logging and evaluation.

Such a BSCW server was used for the co-operation within project Pro-Teach-Net for sharing discussion papers, project states, and meeting minutes. The structure was adapted from the modules of the e-learning environment, so that an easy transfer of the data was possible.

4.3. Selection of a suitable platform

The information-technical design of an e-learning platform covers all concepts for the conversion of the storyboards to the multimedia platform. This includes the analysis and selection of a suitable development environment, survey of the possibilities for the supply of new contents, their preparation as well as their flexible enlargement.

For the realisation of the platform investigations to different e-learning platforms were performed. **Figure 7** shows an excerpt from the evaluation matrix (based on [7]) of the examined e-learning platforms. On the basis of these results a pre-selection of potential systems and systematic tests by the involved institutes were made.

Student's Environment						Teacher's Environment and Pedagogical Tools							
Products	Hyperwave	WebCT	Learning Space	DLS	IBT								
Access to Course Material						General							
Keyword search	+	++	-	-		Multiple teachers support		+	+	++	++	++	
Searchable image archive	-	+	-	-		Teamworking							
Course download / off-line working	-	+	-	-		Teacher can set up group of students		++	++	+	+		
Course can be printed	-	+	-	-		Group file upload capability			+		+		
CD-ROM support	+	+	++	++		Tutoring							
Ergonomic user interface	+	+	+	+	+	Asynchronous tutoring (i.e. by email)		++	++	+	++	++	
Private space and customization						Synchronous tutoring (i.e. Audio-video-conference)		-	-	++	++		
Student can make private annotations of course material	-	+	-	-		Teachers can assign specific course material to group of students		++	++	++		-	
Student can make bookmarks	-	++		+	+	Course evaluation							
Individual choice of learning sequence	+	+	++	++	++	Trace of student's paths through modules		+	++	++	+	-	
Resume learning session						Statistical/graphical reports		++	++	++		-	
Calendar tool	-	++		+		Grade management			++	++			
Student presentation area	+	++	-	-	-	Administration							
Customisation of "look and feel"	+	+	-	-	-	General							
Username and password security	+	+	+	++	++	Registration and follow-up of students		++	++	++	+	++	
Asynchronous student-student communication													

Figure 6. Excerpt of the evaluation matrix [7]

On the basis of a criteria catalogue, WebCT was selected for the implementation of the e-learning platform Pro-Teach-Net. In this catalogue on the one hand the requirements from the students' point of view and on the other hand the ones of the lecturers were regarded. During the selection of the e-learning platform the IT systems of the future students had to be considered too. The software systems (operating systems, CAD, EDM, etc.) available to universities and students differ. For that reason, platform independence is a very relevant factor within the selection process. This focus affects the type of the chosen documents as well as the selection of the software tools.

4.4. Implementation of the learning environment in WebCT

WebCT is a software for provision and administration of Internet-based courses [6]. It runs on a Web-server, which can be accessed by lecturers and students with a browser. WebCT represents contents on the basis of HTML pages and administrates all popular document formats as a file server. Additional materials, which are not used in a course directly, can be integrated in the form of links, which refer to files on WebCT or also to other web pages.

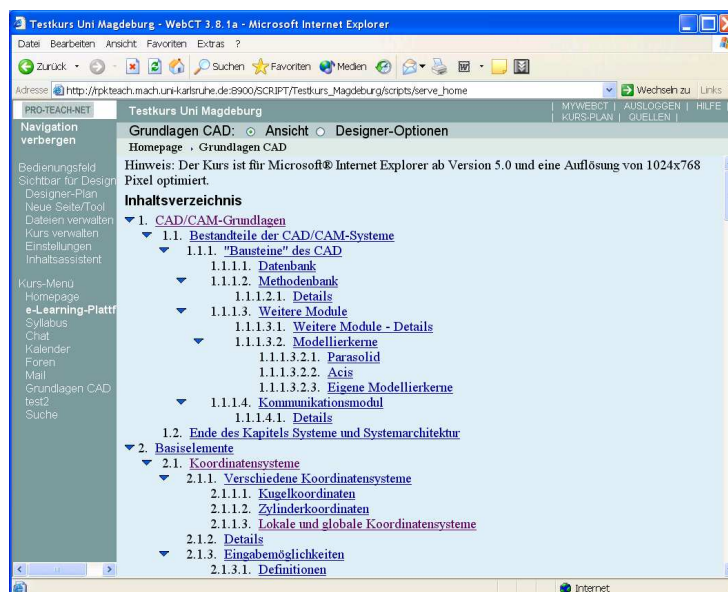


Figure 7. Example of a structure in WebCT

Contents prepared in the storyboards were integrated in WebCT using the so-called contents module. **Figure 8** represents a hierarchical structure of course contents that can be developed with these tools. These structures were developed within the project for each course, whereby most modules are represented by several courses.

Other important tools for the creations of courses in WebCT are

- the curriculum, which is a short description of the course with course contents, responsible person, place, and time,
- the graphics data base, where the graphics can be stored, and
- the glossary, where key words and technical terms are described.

For the students, who can access the contents by a Web browser, the environment is presented as in **figure 9**. The example shows an excerpt from the course “CAD Basics”, where the theory of the creation of geometry is described.

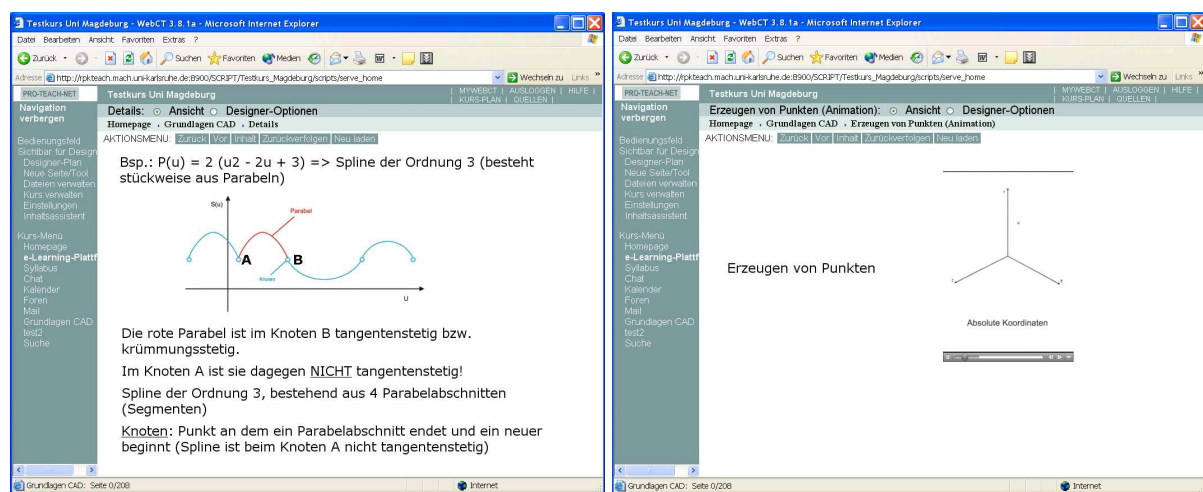


Figure 8. Example of a students page in WebCT

On the left side of figure 9 a content page with a picture is represented. The student will learn the possibilities of creation and representation of splines. On the right side the generation of points is depicted in a video. The lecturer is able to provide the access to these contents to a specified date, so that an effective preparation of the students for their next lesson is possible.

The most important improvement compared to the classical learning forms are the tools for the support of communication between the students and lecturers as well as between the students themselves. Different tools can be used for that:

- A discussion forum, which allows the filing of messages in a structured form,
- chat rooms, which enable a discussion with the students in real time, and
- e-mail for private communication between the lecturer and students.

Assignments are a substantial instrument within the learning process [5]. Every student must prove whether he successfully completed a single section or the entire course. That way he gets an immediate feedback about the state of his accomplishments. In return, the lecturer can analyse the strengths and the weaknesses of the students and can form conclusions about the quality of the learning modules. The student is in contact with the lecturer via the platform, either by forum, e-mail, or file transfer. Assignments take place in different form, which can be subdivided as follows:

- Multiple choice questions or quiz, which provide a defined number of possible answers to a question,
- tasks, where the result is to be entered, and
- assignments and reports, which are transmitted to the lecturer in electronic form for review.

5. Application of the platform in study courses

First evaluations of the learning platform were carried out in the summer semester 2003. A group of selected students received access to the platform in order to test it effectively and receive support by the tutors. The platform is used within the study courses in the following application scenarios:

- Lecture preparation and wrap-up
- Execution of tutored and autonomous trainings
- Provision of modules for self-studies

In scenario 1 the platform serves as portal for the students to provide the utilised lecture documents as well as a preview on future topics. The students can prepare themselves, ask specific questions, and discuss with the lecturer. A further advantage is in the improved quality of the lecture materials.

Scenario 2 is concerned with the execution of the exercises and training using the platform. There are guidelines, examples, and tasks available. The processed tasks will be sent to the lecturer via the platform. Questions and problems can be discussed in available forums and chats between the students and between students and tutor.

For students, who cannot participate in the regular lectures and training sessions for certain reasons, will get access to the platform for self-instruction (scenario 3). The contact to the lecturer is made by forums on the platform, chat, or mail. Especially students who spend one or more semester abroad can study further themselves in such a way.

For examinations the platform will not be used in the foreseeable future. Among technical difficulties legal aspects must be observed. In the examination regulations of the involved universities written and oral examinations are clearly defined and can only be changed with difficulties.

6. Conclusion

The students favourably accept the application of Internet-based technologies in education. By employing new media the descriptiveness and the practical relevance are improved [4]. The didactical preparation of the contents requires a high effort (up to 100 hours for one hour of learning unit), which is reflected in an increase of the quality of the offered courses.

The presented e-learning platform will not replace the classical lectures and tutorials. Social competencies such as team spirit, communication etc. can only be formed by personal meetings. The lectures and exercises are supported by the Internet-based platform, which helps with the preparation and reflection of factual knowledge. The main aim of the personal meetings is the inter-linking of the acquired knowledge. The training aims shift from the classical learning of facts to an application of knowledge.

The testing and evaluation of the platform are still going on. The results of these tests will show whether the platform is accepted by the students, which kind of difficulties will arise, and what feedback will come up.

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