

BLENDED LEARNING IN PRODUCT DESIGN EDUCATION AND TRAINING

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ABSTRACT

The transition from conventional to virtual product design leads to an enormous demand for education and training in most industrial enterprises and universities. The new computer based learning methods can facilitate and help to improve the teaching and learning processes. First the paper gives an overview and classification of existing learning methods and techniques under consideration of the specific requirements for product design. Blended Learning is a recently developed learning technique which combines the advantages of existing and new e-learning methods. Furthermore the paper presents the application of the Blended Learning approach at ITM in the instruction of virtual product development methods for product design. The experience gained at ITM, the advantages and disadvantages of the method are described in the last part of the paper.

Keywords: blended learning, virtual product design, 3D-CAD, e-learning

1 CLASSIFICATION OF THE LEARNING METHODS

Today's usual learning methods are either conventional or computer aided (see fig. 1). In recent years, new computer aided solutions have come in addition to the classical conventional learning forms such as lectures or individual learning with similar media (e.g. printed media). Computer aided learning is learning with the help of digital audio and video media and/or learning software (Computer Based Training) or using internet technologies (e-learning). E-learning signifies the use of internet based technologies to convey clearly defined learning contents [1]. It encompasses not only the contents' delivery over the computer or the internet, but also planning, administration and structuring of the entire learning process.

E-learning did not fulfill the big expectations despite the large investments in the production of learning contents. The reasons for this were:

- exaggerated expectations for cost and time savings,
- unsatisfactory analysis of the contents' suitability for e-learning,
- use of unsuitable e-learning-methods,
- poor acceptance and motivation by the students.

A hybrid learning method brought about improvement of the acceptance of e-learning in the last few years. Blended learning is a healthy mixture of the classical conventional learning and e-Learning. It combines the best traditional methods of executive education with materials delivered via new media such as the internet [3].

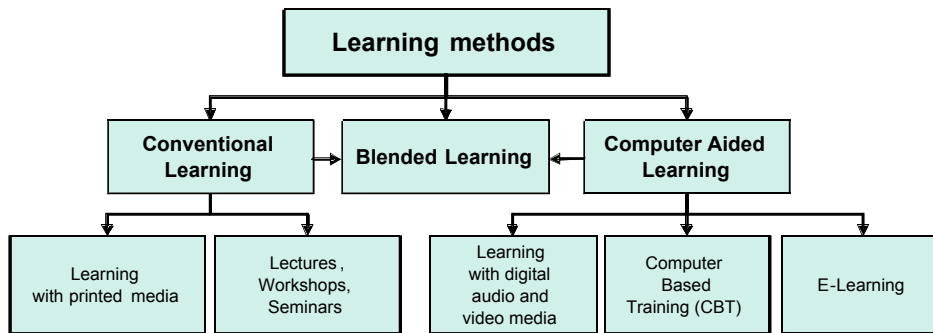


Figure 1. Overview of the learning methods [2]

2 PRODUCT DESIGN REQUIREMENTS ON THE LEARNING FORMS

The product design covers the conceptual and rough design and the virtual product development (see fig. 2). Important are the verification and simulation of the appearance and behavior of future products by software tools based on digital models. These include continuous data and process management and require new operating workflow and work methods.

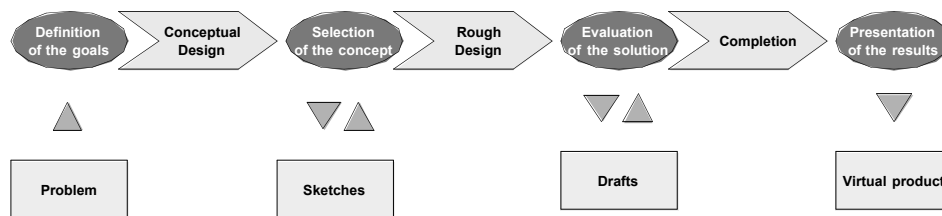


Figure 2. Product design phases [4]

The first phase of product design is the conceptual design. It starts with the definition of a problem and its requirements. The used product development methods are very specific. Finding a suitable concept requires intensive teamwork and communication amongst the team members. The result of this phase is the selection of an adequate concept based on sketches. It must show the general functions of the future product.

The second phase is the rough design. The developers prepare detailed drafts based on the sketches, which must illustrate the feasibility of the solution. The development team uses various software tools and methods. The results of this phase are detailed drafts and simulation results. This phase requires distributed work. Typical for most product design projects is each team member's task allocation with their own deadline.

The last phase is the completion of the virtual product. The result is a detailed 3D model with all necessary documentation – drawings, part lists, calculations etc. The development team must present the virtual product. This phase requires intensive coordination of the team members.

The described product design model defines high requirements on the used learning methods. They are based on complex products; team and distributed work; space and time allocation of the team members; and communication need. Some of the learning methods important requirements are listed below:

- problem solution oriented learning methods (specific industrial exercises)
- high flexibility of the use (space and time allocation)

- integrating learning concepts in the work process (complex products)
- communication tools to support the students (with tutors and in the team)
- modular structure of the contents (flexible use)
- graphic orientated user interface (increase of acceptance)
- self-control possibility of the learned contents
- integrated feedback system for the students (feedback on the state of training, learning achievements, experience control)

The following knowledge should be obtained by the learning concepts in the product design:

- knowledge of the common methods (e.g. 3D modeling, simulation, process management)
- system specific knowledge (e.g. CAD, CAE, PDM)

3 SELECTION OF A LEARNING METHOD

In order to be successful, we must analyze the three main elements of every learning method - training goals, target group and learning contents, very thoroughly.

First we must specify the learning problem or goal. One of the main goals is to improve the students' successful learning.

It's important to find out the audience's characteristics. Important are the available time; required learning style and education level; motivation and expectations. Lastly we must determine the characteristics of the contents. Regardless of which learning methods we choose, we must divide the contents into several parts according to the training conditions. If we choose blended learning we must split the contents into a conventional and an e-learning part.

The results of our analysis are the scenarios of the lecture with all elements that will be developed. The next point is the definition of the use of communication methods. If we choose e-learning or blended learning they are synchronous or asynchronous. As an example we can choose some of the following communication methods: e-mail, forum, chat, videoconference etc. Not all of them are relevant for all learning groups and their contents.

Next we must analyze the suitability of the different learning methods. The analysis of the product design process concerning the efficiency of the learning methods is shown in fig. 3.

The experience of ITM, collected during different industry and research projects (for example two current projects) serves as a source for this figure.

Very complex multimedia web based trainings about calculation methods were developed during the research project "e-engineering center" (funded by the European Union) in co-operation with a German medium-size enterprise (TEDATA GmbH).

In another co-operation project with a supplier for the automotive industry (Keiper RECARO Group) different internal analyses were accomplished as basis for new concepts and solutions for the training of the staff.

The product developer uses very specific design methods (Brain storming, 6-3-5 method, "House of quality", etc.) in the conceptual design phase. It requires intense teamwork and communication amongst the team members in order to find a suitable concept. The classical learning methods are very appropriate for this phase. Here the e-learning methods are not very efficient.

CAD, CAE and PDM tools are very important for the form design phase. E-learning is very efficient in this phase. The student can choose when and where they want to learn to use different software tools.

The result of the last phase is the detailed 3D virtual model. This needs a lot of iterations. The e-learning methods allow a very flexible coordination of the team members. The conventional learning methods require much closer teamwork. After completing all phases the development team has to present the results. The coordination of the members through e-learning tools is very extensive. The conventional learning methods bring better results. The well balanced use of e-learning and conventional learning methods can improve the results in the product design process. This shows the approximate high efficiency of blended learning methods.

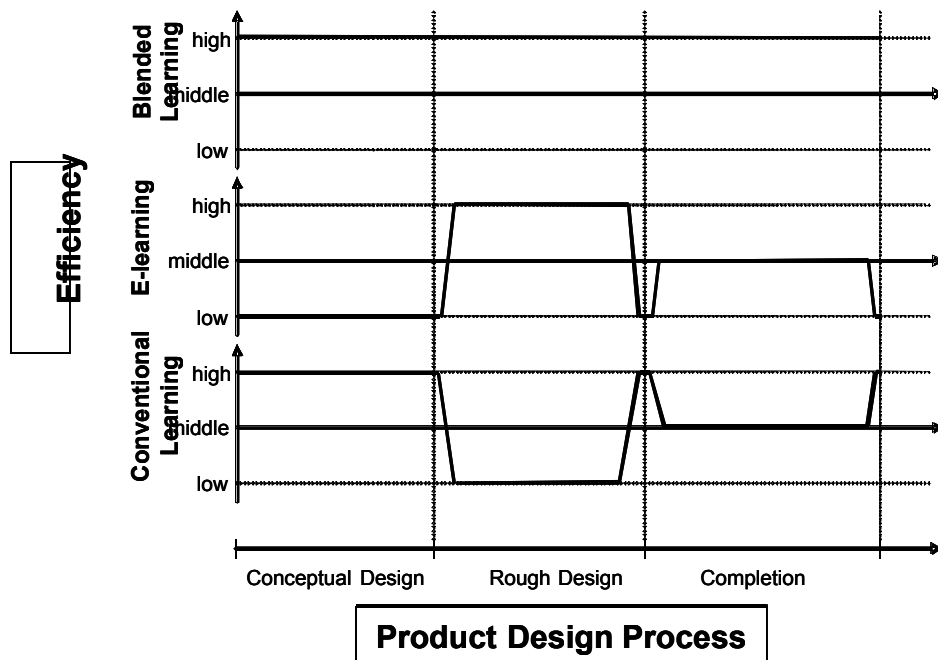


Figure 3. Efficiency of the learning methods in the product design

4 PRODUCT DESIGN TRAINING WITH BLENDED LEARNING

The “Product Design Training” is a part of the main study period lecture “Methods of the Information Technology”. This lecture consists of two courses: “Computer Based Product Development” and “Product Data Management”.

The “Product Design Training” takes 14 weeks (four hours per week). Students need approximately additional thirty hours in efforts for self-preparation.

The learning platform used is “Blackboard” (Blackboard Inc.). The teaching materials are developed almost exclusively at the ITM.

4.1 Introduction in design methods and 3D-CAD

The first part of the product design training is introducing in several design methods. This allows the practical development of new products in the product design project. The introduction in team work techniques is very important.

The second part of the product design training is introducing selected CAD systems in detail. Students are allowed to choose from two CAD systems, which are taught and

supported at the institute (Solid Edge and Unigraphics). The decision to use different systems was made both because some students already have some experience using certain systems and because of the programs' practical use. There are educational versions of each system available to students which they can use to practice at home. The introductory training lasts 3 weeks at the end of which the students should be in a position to develop and assembly parts in 3D. It begins with CAD basic techniques in the first week. The task is to construct each single part of a grinder. All contents are placed in the university's e-learning portal. Figure 4 shows the structure of the learning platform.

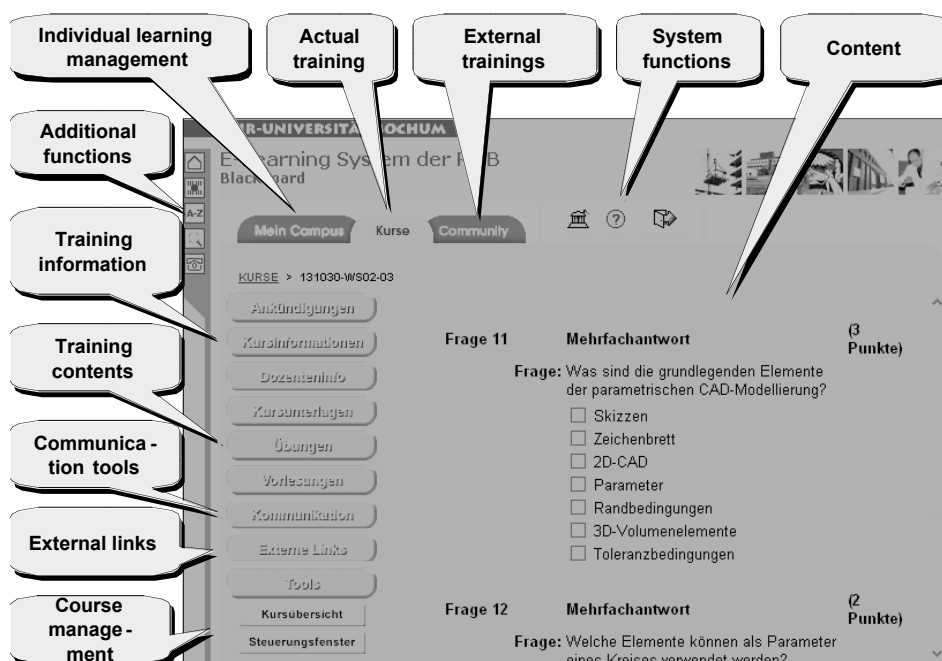


Figure 4. The structure of the learning portal

Students can use either an instruction manual, published in the e-learning portal, or a paper version instead. The supervisors personal support plays a very important role during this phase. Most students are using a CAD system for the first time and need a lot of support.

Assembly modeling is the second week's main topic. Students assemble the parts they modeled in the first week and use additional standard parts from the e-learning portal. Moreover the finished assemblies can be stored online and can be sent to the supervisors.

Additional topics are treated in the last part of the introductory course. The first main topic in the third week is free form modeling. Appropriate prepared digital models are available at the portal. The second topic is the CAD data exchange. There are 10 to 15 models at the portal, which simulate a typical catalogue environment. The parts are from four sample companies, which develop their products in different CAD systems. The task is to assemble the whole product, importing models in native and neutral formats. Controlling the data quality and, of course, the use of different healing functions is very important.

The use of e-learning in the introductory phase is not limited to the online up and download save functions for the CAD parts and assemblies, which are used particularly often by students. The students can send their modeling results to the supervisors, who can examine them and grade the work appropriately. Moreover, the platform is very effectively used at this stage for discussing possible CAD problems and asking trainers for support. Statistics and observation during the last 12 months showed another important field of use. A great number of students, who would like to refresh their CAD knowledge or take first steps in this area, use the e-learning environment whether or not they are participating in the whole course. That is why other institutes notice that the students have a higher CAD education level and are especially in this way, better prepared for student projects.

4.2 Product design project

The most important part of the practical training is the product design project, which is carried out in small groups of 3-4 students. The task is given by an industrial company, which is trying to solve a practical problem and in this way finds a creative solution. Different requirements are set and specified in detail. Not only the technical solution plays a big part, but also assembly and transportation requirements, weight management and the use of standard parts. Although 3D-CAD is the main tool for the project, technical drawings of various parts have to be made. The main concept in this phase is supporting different group processes through the continuous use of the e-learning portal. Each group gets an online project area with a variety of communication functions.

Data management functions allow the controlled access for the group members and significantly simplify the assembly of 3D parts. There are two communication areas. The group communication area has a chat room and a whiteboard, which can be used only by the appropriate group members and supervisors. The common area is used by all students in order to exchange their ideas.

Furthermore, students are supported by an information area at the portal, where additional information is placed, which has been thoroughly analyzed by the institute's staff. There is for example a large list with links to producers of standard parts and part portals, where the students can choose and download different CAD models of these parts.

The project results are presented by each team and are evaluated by a jury. The members of the jury are the representatives of the customer company and the institute's employees. Maybe not the most important goal for students, but still a significant incentive, is the prizes, presented by the company. An oral presentation was chosen because in general students do not have a lot of opportunities hold talks in front of many listeners during their studies. In order to create a situation similar to the one in the industry the presentation is similar to a sales event. Each group asks its "opponents" a lot a questions and tries to find shortcomings in their technical solutions. There is additional training before the final presentation, in order to prepare the students in dealing with the appropriate software. There is a unit in a practical training, where some of the CAD functions are dealt with, which could be useful during the presentation: recording a motion in the assembly, photo rendering or exploding assemblies. Some of these applications are described in instructions, which can be used at the e-learning portal. The competition causes an increased use of the portal, not least because of these manuals and different FAQs.

5 CONCLUSIONS

The use of new educational methods like Blended Learning can bring many advantages, if different critical issues are considered. The experience, gained at ITM, demonstrated many advantages and chances for Blended Learning methods:

- Constant accessibility and better flexibility concerning location and time,
- Increased training motivation through the use of interactive and multimedia elements,
- Supportive team work and “learning by doing”,
- Time relief for tutors

Nevertheless some difficulties were identified in the course of the last 2 years. The use of the new tools is not mandatory. Although the majority of students intensively use this offer, there are some students who persistently reject these web tools. In order to encourage this group, ITM plans to introduce some incentives like additional credit points for exams. Moreover the use of the internet often requires a broadband internet connection when downloading large assemblies. However this will certainly soon be solved soon through new telecommunication technologies.

The prospect for Blended Learning is very promising. Although the offers for Blended Learning in the engineering design field are poor, this market segment is constantly growing. ITM has carried out some projects with partner companies and has transferred own experience to the engineering industry.

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