

USE OF BLENDED LEARNING FOR VOCATIONAL TRAINING OF TECHNICAL PRODUCT DESIGNERS IN GERMANY DEVELOPED BY THE FACULTY OF MECHANICAL ENGINEERING OF TU DORTMUND UNIVERSITY

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Abstract: *The research project "Third Place of Learning" ("Dritter Lernort", abbr. DLO) connects the vocational education system of technical product designers with a web-based learning platform. The content is produced along a didactical concept. It includes interactive examples, exercises, tests, scripts and videos which increase the motivation of trainees. Through the use of DLO trainees are able to study self-paced and independently of time and location. The platform is not only suitable for trainees, but also for business-instructors and vocational teachers because of the provision of study materials. The aim of DLO is to optimize the quality of vocational education by using a blended learning system. Moreover the faculty of mechanical engineering wants to explore additional potentials of blended learning in general.*

Keywords: *blended learning, e-learning, technical product designer, vocational education system, online*

1. THE THIRD PLACE OF LEARNING

The "Third Place of Learning" (abbr. DLO - "Dritter Lernort") is a research project which deals with the development of a teaching / learning platform for technical occupations. The target group are apprentices, trainers in companies, as well as teachers at vocational schools. Currently, the platform is designed specifically for the education profession of technical product designers, but can also be used for many other technical occupations.

With the help of using DLO, training in technical occupations should be optimised by nationwide use of new developed e-learning concepts and new e-learning materials. A further objective is to reduce the number of crashes of vocational training and to improve the quality of education. Because of the omnipresence of the internet, the users can determine the time of working with the platform, as well as their individual work pace. The platform also offers advantages for people who are already active in the learned profession. There is the possibility to insert the content, to refresh skills and to gain knowledge, which has not been taught in the own training.

Thus, DLO is also a tool to support lifelong learning. The platform provides the necessary "method expertise for targeted, planned approach to editing professional tasks and problems" [1]. This happens through that "learners

can access appropriate learning and working techniques" [1].

The project, under which the platform has been developed, is edited from the department of machine elements of TU Dortmund University in cooperation with the department of technology and its didactics of TU Dortmund University. As an industry partner, the kajado GmbH, Dortmund, is involved. Project promoters are the Bundesministerium für Bildung und Forschung (Federal Ministry of education and research) and the Deutsche Zentrum für Luft- und Raumfahrt (German centre for aviation and astronautics) (DLR).

2. CONTENT OF DLO

Essentially, the platform DLO offers tools for knowledge transfer, knowledge checks and interaction possibilities.

The transfer of knowledge is founded by teaching materials in form of lessons, exercises and instructional videos. Because it is possible to use the media of DLO independent of time and location the teaching is more effective. The entrance in new treated subject areas is simplified by that because the content can be used individually for each type of learning.

Whether the desired learning objective has been achieved can be tested by knowledge controls, which are designed

as quizzes. By this tool the reviewer feedback qualified immediately after the completion of the quiz. Based on this, it can be decided which lessons have already been understood and which shall be repeated.

Interaction possibilities also exist in the form of forums, the exchange of knowledge between the persons involved can be made and that can be used for the building of learning collaborations. Also suggestions for the further development of the platform can be given, and in designing additional content can be collaborated individually. DLO serves as an interface between the vocational schools, the training companies and the apprentices.

In the following the structure of the lessons is explained on the basis of an example of "section view". After opening the lessons the learning objectives are presented first. Furthermore it is specified, which prerequisite knowledge for the processing of the course is required, shown in image 1.



Image 1: Example of the first page of a lesson [2]

The content appears on individual pages in the form of images and descriptive texts after starting the lesson. It has been a special advantage that especially images of a self-made textbook [2] could have been used. In this respect proven material, which has already been used in numerous courses at TU Dortmund University, have been used successfully.

Moreover the rights of this purpose belong to the author and thus the processing centre. Because of this special situation, it has been possible to simplify the development of the platform significantly.

The controls of knowledge are used to verify the acquired knowledge and should help the apprentices to decide whether the lesson should be repeated completely or at least partially based on the result. Image 2 shows an example of content of a lesson on the subject of section view. Image 3 shows an example of a knowledge check. Here is shown a component in front view and in top view. To select the correct section view the apprentices can choose between three possible solutions.

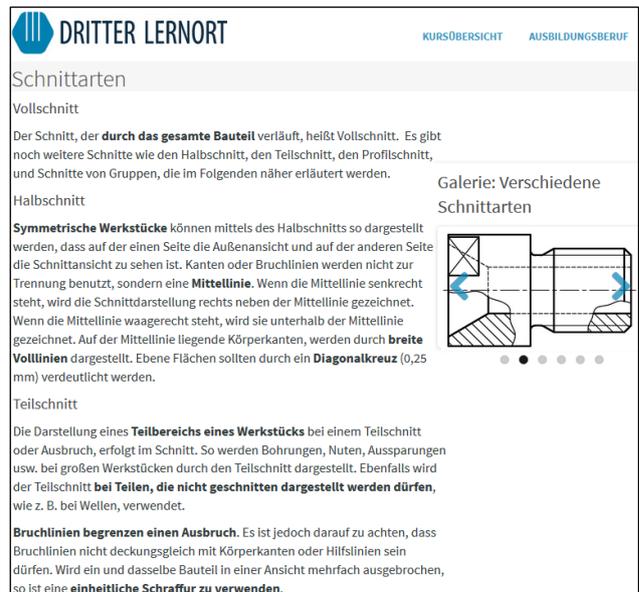


Image 2: Example of content of a lesson [2]

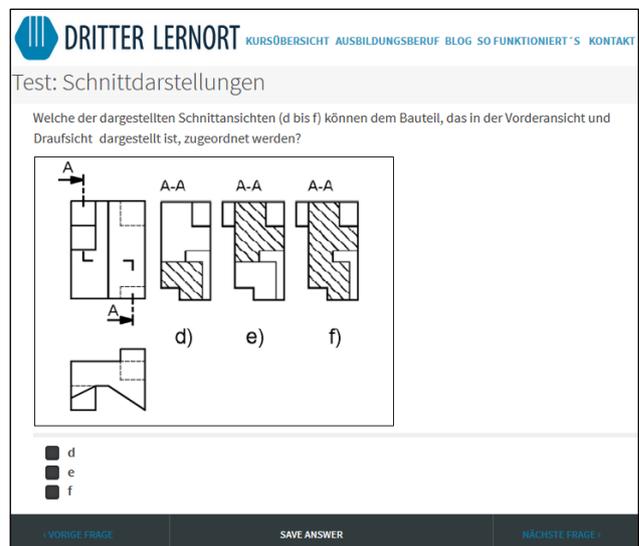


Image 3: Example of a knowledge check [2]



Image 4: Video „thread cutting on a lathe“ [2]

Videos which have specially been made for the platform are used to illustrate production operations. These include, for example, videos about the editing using a lathe (turning, facing, thread cutting, etc.), milling, the manufacture of gaskets, etc. Videos also exist in the area of technical drawing. To these tasks, that are available in the appropriate lessons, solutions are presented, which are drawn freehand. Image 4 shows the view of a video for thread cutting on a lathe.

3. 3D-PRINTING IN THE APPRENTICESHIP

In the course of the project, it became obvious that the importance of 3D printing has been increased massively, especially according to the FLM procedure (FLM – fused layer modelling). Nowadays the use of 3D printing wins more and more of importance. Due to the low cost of equipment itself as well as the necessary materials, this technology has found a wide field of application.

The responsibilities of the technical product designer include the creation of the necessary drawings or 3D data sets as well as passing data to the printer. For this reason, it is essential to treat even this issue in the context of training. Accordingly, the examination regulations of the training of apprentices to the technical product designer have been modified and the transfer of knowledge in the area of 3D printing has been included.

In the practical implementation there are several problems, particularly in the vocational schools. Often there is a lack of funds for the procurement of equipment and expendable materials. In addition, often there are just a few or even no experiences in dealing with the technology. Therefore a long training period is required for the teachers. Also security questions have to be regarded in order to avoid potential hazards during the use of the equipment as far as possible.

To solve this problem, two 3D printers were purchased in the project DLO. Two devices of the type Prusa i3 as a kit were bought as a result of the excellent price-performance ratio. The low acquisition costs allow both the apprentices and the school to buy similar equipment, if funds are available.

First of all, the kits were assembled. To enable a trouble-free reproduction here, building instructions were created in the form of commented videos and made available online in DLO. In addition, operating statements and risk assessments were developed and also made available online. In addition, the necessary process knowledge for the correct setting of software and printer is disposable.

In the next step, two modular trolleys were designed and built. Each trolley consists of a chassis, a closed board with transparent walls, containing the 3D printers, and an unit with two drawers, in which the material in the form of the filament (PLA – polylactic acid) is located as well as some standard tools on the one hand and a laptop on the other. The board prevents intervention in the hot printing range and has a door, at whose opening the printer will shut down. The three modules can be rigidly connected and then transported. They can also be separated from each other, so they are easily to carry, see image 5.

Further on, a laptop with the necessary software is available for each trolley. This is the software to control the printer (called “slicer”) and the 3D CAD software Autodesk INVENTOR. This program is available free of charge for educational institutions under the link <http://www.autodesk.de/education>.

A trolley can be borrowed free of charge by schools. Because the whole necessary information, tools and materials are available, this is the best way to support the intro-

duction of the 3D printing technology in the dual vocational education.



Image 5: Modular trolley with 3D printer

The possibilities to borrow the two trolleys by the cooperating schools were often taken up whereby good experiences have always been collected.

4. CONCLUSIONS

The research project DLO has made a promising start. The implementation of DLO has already produced a number of positive results. Currently DLO is in the test and pilot phase in order to guarantee that the learning platform works correctly and that the course contents are complete.

During the whole pilot phase of the project the teachers, business instructors and apprentices have been interviewed and will be interviewed further more. There is one questionnaire for the apprentices and one questionnaire for the teachers and business instructors because of the different demands on the platform they have. By evaluating the questionnaires it should be checked whether the course contents should be modified or completed and it has to be controlled whether the website is basically working and can be used.

During the current project time the examination regulations of the training of apprentices to the technical product designer have been modified and upgraded to the latest technological standards. From now on the apprenticeship should include typical vocational action situations to improve the professional action competence. To adapt DLO in the new contexts, the department of machine elements bought two assembly kits of 3D printers. The department of machine elements supports the schools in working with the printers free of charge. The 3D printers are delivered to the vocational schools and are picked up again after using. After borrowing the 3D printer the apprentices and teachers are interviewed to figure out the advantages of working with the printers and to value the result of it.

The next time will be used to optimize the platform continuously, based on the results. The informing of teachers, business instructors and apprentices will be continued in order to increase the number of users. The reputation of the platform should be as high as possible. To summarise, it can be noted that DLO is a suitable project to improve the quality of the education.

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