

HIGH INTENSITY LEARNING OF CAD EMPOWERED BY A SIX-T-SYSTEM

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ABSTRACT

This paper presents how individual learning of CAD can effectively be enhanced by a system of six interlinked components. This CAD course aims at lifting as many students as possible to a preferably high and well-defined level of competence. At the same time, the teacher's workload can be kept within limits that allow him or her to spend the majority of his or her capacity on supporting the individual student. In order to reach this aim in spite of common unfavourable teaching conditions a complex pedagogical concept of individual learning in large groups has been developed.

The six key elements of this concept are the following:

- *Tutorials*: Imparting content and methods by way of video-tutorials, including adoption of the new material by becoming actively involved.
- *Training*: Practicing the new material by repeating and training CAD strategies and software commands up to firm mastering.
- *Transfer*: Transfer of the newly acquired competences to more sophisticated problems based on successful completion of the component's tutorial and training.
- *Team-Tutoring*: Support in case of problems is given promptly by networking in learning groups of four.
- *Tutor-Attestation*: Permanent and immediate feedback on the participant's own learning progress is provided by the tutor.
- *Trust*: The experience of successfully traversing through the different stages provides trust in the lecturer and in the concepts taught, thus accelerating the learning process.

This course has already been carried out several times with great success at three universities and has been further optimised.

Keywords: Advanced instructions, blended learning, CAD education, didactic conception, individual learning, teamwork, learning processes, soft skills

1 INTRODUCTION

An increasing number of online courses offered by various institutions suggests that high quality knowledge can be easily offered to an increasing number of people. However, university lecturers are frequently not too pleased with the outcome.

Easy access to the courses does not necessarily facilitate learning success, as indicated by a large dropout rate. It appears that in many cases further optimisation of the course material requires even more self-discipline on the student's side.

In this paper, we illustrate how our didactic system consisting of six components ("Six-T-system") is able to compensate for existing drawbacks.

Our concept aims at providing optimal support to an individual in his/her way of learning while minimising organisational overhead at the same time. The advantages of individual work on one side and the advantages of teamwork on the other side are combined. At the same, the drawbacks of either approach are minimised.

2 FIRST STEPS IN THE LEARNING SITUATION

It is well known that the start in a new institution, especially in view of our large classes of about 200 participants, puts students into an unsettling mood [2]. However, results from brain research show that an individual learns best when feeling comfortable and socially integrated [3]. Therefore, even before the classes begin we assist our students in building working groups of four each. These groups will grow together when mastering unfamiliar situations and will prevent feelings of isolation within large groups from early on. Speaking scientifically, we create an optimal environment for the growth of powerful neural networks in the students' brains.

The learning group provides support for the individuals throughout the course assisted by supervising teaching personal when necessary.

3 COMMON PROJECT OF A LEARNING GROUP

Throughout the course, we will deal with one single, challenging project taken from practical applications. This will prevent students from questioning the practical meaning of the course contents. The project is chosen in such a way that teamwork will obviously be the only promising approach. Each of the four group members will design different elements within the project, thus enabling a rather complex final result [4]. Students will experience different ways of collaborating within a team and connect them to the results produced in a comprehensible way. If everything works well they will be rewarded with the experience of having achieved a rather complex project in joint work.

From a didactical perspective, the main goal is the optimal facilitation of students' progress in his/her ability to acquire knowledge and use different learning and working techniques. If we manage to incorporate this way of thinking into their work on a CAD project, the course will promote the development of their personalities on a higher level at the same time [5].

4 SIX-T-SYSTEM

In the 6T-Turbo-System six components are linked and interlocked by a sequential arrangement. Neglecting one component or even skipping it will result in a serious loss of effectiveness of the system. The course content is divided into five sections and for each the student will go through all components of the Six-T-sequence again. The course comprises 40 hours for the students. Each lesson consists of 22 videos each adding up to six hours [6], which leaves 34 hours for application. To put it explicitly: to really master the presented knowledge, the student has to invest one hour in his own application for every 10 minutes of video.

4.1 T₁-Tutorials

For teachers and for students' videos can be a perfect tool to impart contents and methods. The acquisition of knowledge takes only place on an individual basis. Each individual has his or her own pace of learning and therefore there is the need for an individual control of the progress.

Videos are ideally suited for that purpose (Figure 1 left) when special rules are respected. In view of the students' limited attention span, the videos need to be as brief as possible. Just one topic per video is introduced to enable students to re-locate the precise aspect in case needed without wasting precious time. We use two voices for the students to easily differentiate between mental structuring and step-by-step implementation into CAD. The videos have to be structured into phases to get all attention: we execute what has to be executed by the student, proceed with additional information to prepare the students for transfer and mention frequently made mistakes, so students are prepared to solve them on their own without needing the support of the teacher.

Knowing that a certain piece of information is required promptly activates the human brain considerably. Therefore, we let the students know in advance that right after watching the software input shown in the brief (2-5 min.) video they will solve the task illustrated in the video on their own.

Our goal is that most students watch the complete video fully focused (Figure 1 right). Only in the exceptional case, that someone is not able to grasp the idea after a one-time view of the video a second view of the video may be helpful.



Figure 1. T_1 - Tutoring via video presentation and application via structuring

4.2 T_2 -Training

Many students and some teachers make a fatal mistake, they take watching videos for learning. However, the acquisition of knowledge demands an active handling of the subject. Students definitely have to be given corresponding tasks to apply and train the new knowledge. And the task has to be given quickly after each input, because the quicker you have to apply new information the better does your brain store it.

Therefore, after each video the students have to execute the watched sequence on their own computer. To guide this, we designed an intermediate module between video and technical drawing and call it “structuring of construction” (Figure 2 left). In this structuring all necessary steps are described to transfer the drawing into CAD. This description is given by itemised texts and guiding sketches. It does not refer to a special CAD software but is valid for many CAD products. The structuring does not cover how to operate the software but provides a full list of operations to execute. It helps the students to reflect and understand the process on a higher, on a conceptual level.

Three tools are offered for learning and training: video, structuring, technical drawing. Based on these elements we offer three kinds of applications for students to systematically build up competence by training. The students’ first task is to listen to the complete video, then execute the step guided by the structuring, listen to the next video then execute the step and so on with all 22 steps of the lesson (Figure 2 right). The students’ second task is to repeat all steps of the lesson in one go without needing the help of the videos just being guided by the structuring. In addition, the reflects how the structuring leads to the part given in the technical drawing. The students’ third task should be to execute the lesson again just using the technical drawing (Figure 3 left).

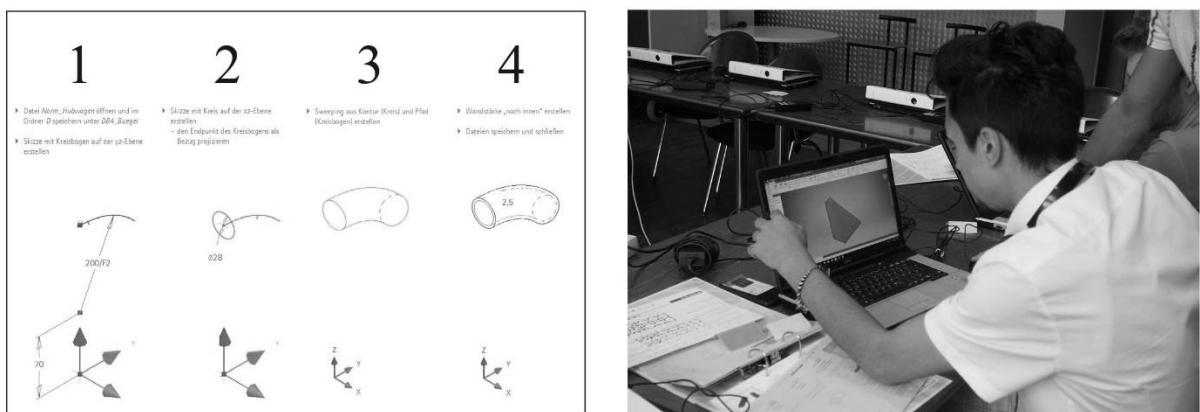


Figure 2. T_2 - Training via structuring of construction

Facilitated by this system of support, in each classroom up to 40 students in 10 groups are perfectly supported by one tutor, a quite cost-effective system.



Figure 4. T₄ - Team-tutoring in learning group of four

4.5 T₅-Tutor-Attestation

For the vitality of the learning, it is essential that the student continuously experiences his progress and thereby is further encouraged in his efforts. The component Tutor-Attestation provides permanent and immediate feedback on the participant's own learning progress. The learning process will benefit from the interplay of the student feeling successful and immediately getting objective confirmation by the lecturer. We developed a special software to guarantee this even in large classes by checking essential aspects. The student uses this software on his own when he has completed a task. He will receive a confirmation of his success or hints for necessary corrections. In case of success, the student will turn to the tutor for an attestation. The tutor will use the software to check all data created. In case everything is visually fine the tutor will issue an attestation (Figure 5).

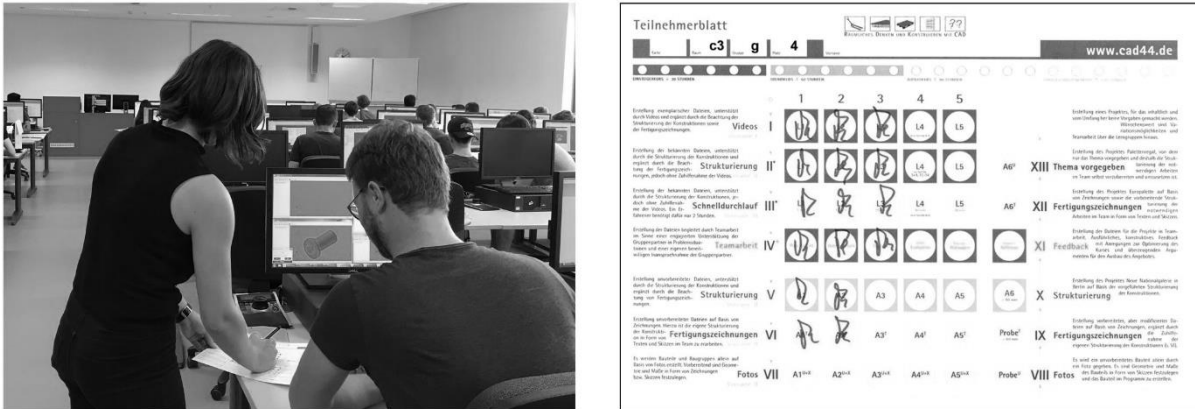


Figure 5. T₅ - Tutor-Attestation and reflection of learning progress

While giving the attestation, the lecturer will discuss with the student his individual learning progress and reflect his use of the Six-T-System. This dialogue will emphasise the students' reflection on contents and methods and, more important, this dialogue will emphasise the importance of reflecting one's own learning process.

Due to continuous and definite confirmation of the successful progress, the student will gain confidence in proceeding on a solid basis. This will result in effective learning, as the more confident you feel, the more energy does your brain provide for learning.

4.6 T₆-Trust

The experience of successfully traversing through the different stages provides trust in the lecturer and in the concepts taught, thus accelerating the learning process. The more trust the student is gaining, the less friction in the learning process will occur. On the one hand, trust means confidence of the student in his own abilities. On the other hand, trust also is the experience-based reliance on the lecturer and his

course concept. Less doubt in the student's mind will result in less friction by unproductive questioning of the concept and in more energy for productive reflection and comprehension.

The lecturer is constantly able to support the building up of trust by removing unnecessary obstacles. He organises the course in a way that unnecessary friction and waiting time are nearly eliminated. T₁: He makes sure to present all necessary procedures in a complete and accurate way in the videos. T₂: He takes care that the training leads to a smooth routine in executing the necessary software commands. T₃: He provides clear and unambiguous problem descriptions for transfer tasks. T₄: To assist team tutoring, he provides and trains competent tutors, who are able to grasp occurring problems quickly and who are able to communicate with students in a friendly and effective manner. T₅: While issuing the attestations he creates a supportive and trustful atmosphere. He demonstrates his own confidence in his course concept based upon a lot of experience and he tackles and reduces remaining problems in an effective and transparent way.

With all these actions, the lecturer builds up trust and trust accelerates the learning progress of his students (Figure 6).



Figure 6. T₆ - Trust in the lecturer and concepts taught

5 SUMMARY

The didactic Six-T-system presented in this paper provides an optimal learning environment for students. Using a pallet truck as application CAD skills will be acquired as well as effective learning and working techniques.

The compact teaching concept enables the acquisition of many facts and complex methods in a brief period. Our experience shows that participants will succeed even in challenging situations thus providing a solid base to approach and manage situations that are even more complex.

Our teamwork concept provides the students with mutual support so that smooth progress is made. Therefore, teaching staff can concentrate on providing supervision only in special situations on an individual basis. In general, all frequently arising questions are dealt with within the group.

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