



## Creativity as a driver for learning computer-aided working methods in the engineering sciences

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The low effectiveness of mere frontal teaching when teaching software for computer-aided work is a challenge for learners and teachers. This article presents how active participation in the seminar and self-study could be improved with little additional effort through the consciously required creative use of the software used.

Die geringe Effektivität bloßen Frontalunterrichts bei der Vermittlung von Software für computergestütztes Arbeiten ist eine Herausforderung für Lernende und Lehrende. In diesem Artikel wird vorgestellt, wie durch den bewusst geforderten kreativen Umgang mit der verwendeten Software aktive Beteiligung am Seminar und Selbststudium mit geringem Zusatzaufwand verbessert werden konnten.

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### 1. Computer programs in teaching

The confident use of various computer programs is an integral part of the profile of most academic professions. Engineering graduates in particular should not only be trained in the use of standard programs, but should also be proficient in more complex special software such as CAD programs, as a large part of the practical application of the skills acquired during their studies is now software-supported or software-based. In order to actually obtain a professionally qualifying degree, dealing with specialized software common in the industry is already part of the course. However, many students find this difficult.

The "digital natives" have a good command of the programs and services they are used to using. However, everyday use of digital technologies cannot be equated with digital literacy. [1] In its report "The fallacy of the 'digital native'", the *ICDL Foundation* argued that the use of digital media by digital natives is primarily life-style-related and that the skills acquired in this way do not represent a significant qualification for the job market. [2]

### 2. Motivation when learning computer-aided working methods

"Motivation" encompasses the setting of goals and the subsequent, goal-oriented action. It is used to explain why actions are started, continued, ended or even omitted. [3, 4]

Motivation and demotivation have many different causes. One possible way of classifying these causes is to divide motivation into extrinsic and intrinsic motivation. Extrinsic motivation" includes the factors that contribute to or detract from motivation that lie outside the individual. "Intrinsic motivation", on the other hand, includes all factors that contribute to or detract from motivation that originate from the individual themselves. [3-5]

Positive motivation is a critical prerequisite for a successful learning process. [6, p. 109f.]

When learning new software, learners focus more on the results achieved and less on the learning progress made. The software is a tool and learners are eager to try it out and use it.

Successfully carrying out actions in the software independently increases intrinsic motivation. Longer explanations or demonstrations covering several aspects of the software and without practical use of the software, on the other hand, cause impatience, as there is no visible learning success. This reduces intrinsic motivation. [7]

Accordingly, independent, practical use of the program while learning the program is desirable from the learner's point of view.

The independent practical use of the software should be instructed in such a way that learning successes become *visible* and set goals can be achieved relatively easily. Failures can quickly lead to learners feeling overwhelmed and incompetent. Perceived incompetence reduces intrinsic motivation to learn, which in turn has a direct negative impact on learning success [7-9].

### 3. Ways to improve motivation

Teachers can create extrinsic motivation through intermediate tests or additional services. [5] Positive feedback and support, as well as setting learning goals and making successes visible can promote intrinsic motivation. [5, 6, S. 133]

However, when preparing and delivering courses, teachers are subject to time, financial and personnel constraints, which make it difficult to put in the extra effort to motivate students.

This raises the question of what possibilities teachers have to increase the extrinsic or intrinsic motivation of students with little additional effort. The following describes how the special characteristics of computer-aided working methods were utilized or addressed in a block seminar in order to increase students' motivation in learning them through creativity and autonomy.

### 4. Course

WE-TEAM is a two-year Erasmus Mundus Joint Master Degree program to train the next generation of textile engineers. The program is

aimed at people with a Bachelor's degree in engineering or natural sciences and has a strong international focus. This is reflected in the heterogeneous distribution of nationalities (class of 2023/2024: 20 students from a total of 15 different countries) and in the fact that students study at a different university in a different country each semester. The participating universities are located in the EU and Japan.

The Chair of Development and Assembly of Textile Products contributes to this program with a four-day block seminar on modeling and simulation of textile products. This is one of the Chair's standard topics, which, due to its scope, is usually dealt with in various courses lasting an entire semester.

The aim of the block seminar is to impart theoretical knowledge and practical skills in the fields of modeling and simulation of textile products, which students can develop and apply independently. Previous knowledge in these areas will be tested at the beginning of the seminar. As a rule, one or two participants have limited knowledge in these areas. The block seminar takes place in the first semester of the Master's course and is held at the University of Ghent.

## 5. Procedure to date

In the first three years, the seminar was organized as a classic frontal lesson. The lecturers demonstrated various programs for simulating textiles and imparted basic background knowledge in a lecture format.

As the students are not in Dresden, they cannot use the professorship's PC pool. Instead, they must use their own laptops. As access to a Windows laptop is one of the admission requirements for the course, it can be assumed when preparing for the seminar that all students will be able to participate in the seminar with their own laptop. However, there are two main restrictions: The software programs must not make excessive demands on PC resources and must not require licenses that cannot be provided due to low availability at the chair. Therefore, preference is given to

software programs during the seminar that students can use without a license and that still run on less well-equipped PCs (e.g. Texgen [10]Blender [11]Python [12]). However, license-based programs (e.g. TexMind Braider [13], VStitcher [14]) are also used, for which a license can be provided by the chair.

The skills learned were tested in the form of a take-home exam, in which the students had to complete defined tasks with the software they had learned and submit the solutions. The students had several weeks to complete the tasks. In this format, collaboration between students when completing the assignments cannot be ruled out and is not undesirable in terms of mutual assistance. However, students are given individualized tasks; for example, different tissue connections to model or different bodies to be included in a simulation.

The longer processing time for the tasks should enable students to develop their skills independently. At the same time, the tasks should not demand significantly more than was taught in the course.

The resulting artifacts were closely oriented to the minimum of the task, were very similar to each other and the functions used were almost exclusively limited to those that had been explicitly demonstrated during the course. The



Figure 1 3D model of a heart-shaped 3D mesh

aim of imparting basic skills in the fields of textile modeling and simulation was thus achieved. However, it was not clear from the results whether the students had developed their skills independently or could do so and whether they were able to apply the knowledge they had acquired confidently or replicate demonstrations from the course.

Overall, they did not appear to have been motivated to learn independently as a result of the course.

## 6. Modified procedure

The seminar was modified in the fourth edition with the aim of motivating students to engage more independently with the material and making their learning process and learning success more transparent.

(1) In order to achieve a greater sense of achievement during the initial exploration of the programs, the focus was initially placed more on processes and functions that **quickly** deliver **visible results**. For example, instead of explaining the functions of the *TexMind Braiding Machine Configurator* and the underlying theory of braiding in detail, initially only a simple braiding machine was modeled and a 3D braid was created. These work steps can be implemented in the software with just a few clicks.

(2) In order to encourage the students to use the software confidently, the students were asked to explore the other functions of the programs themselves in a free work phase after learning the basic concepts and to work **creatively** and, for example, to create personalized or comical scenes. The possible self-realization and self-efficacy should increase intrinsic motivation. Figure 1 shows an example from a similar task with the *TexMind Braiding Machine Configurator*: The student has built a braiding machine that creates a heart-shaped braid and dyes it pink. In order to achieve this result, she had to make significantly more use of the program's range of functions than had been demonstrated by the lecturer.

The lecturer and fellow students present were able to provide quick assistance during this free phase in order to keep the students motivated.

(3) In order to provide an incentive to put creative ideas into practice, the results achieved could be **shared voluntarily** and were discussed together at the end of the lesson. This was done with the intention of using the recognition of the seminar group as extrinsic motivation. (4) The Take Home Exam was supple-

mented by a learning diary, assessed for completeness, expression, form and design, in which the students should record their learning progress and reflect on it themselves in order to be able to better understand it during the assessment.

(5) As far as possible, students were offered the prospect of bonus points for creativity in the assignment. The assignment was broken down into points for this purpose, so that the assessment was transparent for the students from the outset. The tasks that allowed for creative engagement (e.g. modeling a fabric, simulating a scarf, modeling a bracelet and simulating a product presentation) were each awarded one bonus point for creativity. The point was awarded if the artefacts were designed, e.g. through color or shape (see e.g. Figure 2).

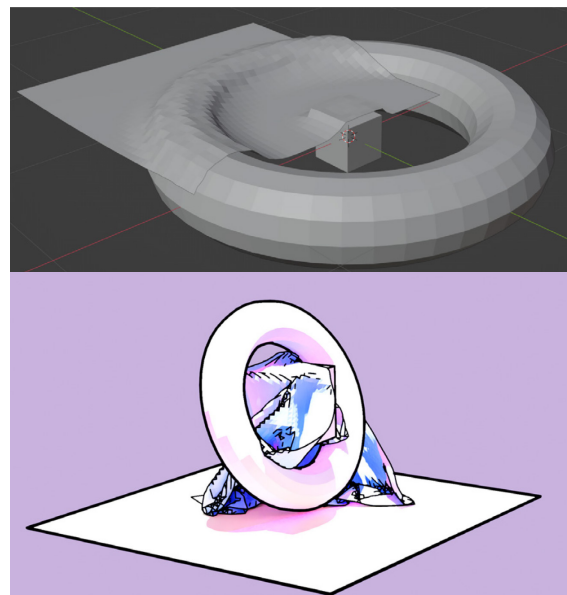


Figure 2 Screenshots from two draping simulations. Top: Implementation of the minimal task (recreation by the author) Bottom: Implementation by the student. The surfaces are changed by the creative use of shader effects, the material parameters of the cloth are modified, the cube rotates around itself, the torus rotates around the cube.

## 7. Results

According to the lecturer's impression, the participation and commitment of the students during the presented edition of the block seminar noticeably exceeded that of the previous editions. The students quickly became actively involved in the course and were motivated to

explore the possibilities and limits of the programs. The joint debriefing of the results was very well received by the students and enjoyed lively participation. Both were reflected in the fact that during the free work phases, most students submitted at least one and usually several different artefacts for joint discussion, in which not only the previously demonstrated program functions were tested, but also new functions were used that the students had used on their own initiative.

When taking the exams, i.e. creating the artefacts in accordance with the task, the candidates applied the programs they had learned with a degree of experimentation and confidence that went far beyond the level taught in the course. In some cases, even the learning diaries were creatively designed.

The students were not only able to apply the knowledge imparted during the seminar, but had also independently acquired and implemented new knowledge. Despite a lack of prior knowledge in the application of the programs presented, the students quickly built up skills in the areas of modeling and simulation. This was mainly due to successful self-study. This was also evident in the learning diaries during the assessment. The students rated their personal learning progress and the course as such very positively.

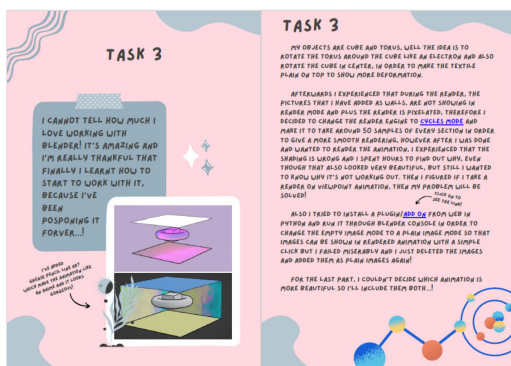


Figure 3 Creatively designed page from a learning diary

## 8. Discussion

In the course presented here, the students were asked to explore the demonstrated and, if necessary, other functions of the software themselves in a free work phase after short familiarization and demonstration phases to

teach them practical skills in using computer programs. This was done with the aim of motivating the students and encouraging them to learn more independently. During the free work phases, they were encouraged to implement creative ideas wherever possible. The results were then discussed together afterwards. While the independent implementation of their own ideas was intended to increase the intrinsic motivation of the students, the joint comparison was intended to achieve extrinsic motivation through the recognition of the group. When the examination was taken, it became apparent that the students had deepened their knowledge and learned new skills following the course itself. This could be due to the fact that the students were motivated by the aforementioned measures.

The examination was carried out in the form of a take-home exam in which the students recorded and reflected on their own learning progress. This made it easier to understand how the performance had been achieved during the assessment.

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