

HYBRID TEACHING AND LEARNING ENVIRONMENT IN THE CONTEXT OF VIRTUAL PRODUCT DEVELOPMENT

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ABSTRACT

Product development means identifying the needs of different stakeholders, developing a product for them to the point where it is ready for production and use, and documenting it. To manage the complexity of product development, it is becoming increasingly digitalised. As virtual product development is a key area of industry, teaching in this area is an important component of a practice-oriented engineering curriculum. Engineering education constantly requires new teaching and learning formats. The trend is towards a systematic combination of digital teaching materials for self-organised individual and cooperative self-study on the one hand, and in-depth forms of classroom teaching tailored to the needs of students on the other - in short: hybrid forms of teaching and learning. Within the framework of an eTeach impulse project for a hybrid teaching and learning environment for virtual product development, important results have been developed, implemented and evaluated to achieve this goal.

Index Terms - Product development, Virtual Product Development, CAD, eTeach, hybrid teaching, hybrid learning, competence-oriented learning

1. MOTIVATION AND OBJECTIVES

Product development means identifying the needs and constraints of various stakeholders, developing a product for them until it is ready for production and use, and documenting it in the form of a comprehensive product description. To manage the complexity of product development, it is becoming increasingly digitised. Parametric 3D CAD systems for the creation of digital product models and data systems for the management of the models are a decisive cornerstone for this. As Virtual Product Development (VPE) [1] is a key industrial field, training in this area at the beginning of the degree program is an important building block in a practice-oriented engineering degree program.

Engineering education constantly requires new teaching and learning formats. The trend here is toward a systematic linking of digital teaching materials for both self-organized individual and cooperative self-study (online learning) on the one hand and in-depth forms of classroom teaching tailored to the needs of students on the other, in short: hybrid forms of teaching and learning. Within the framework of an eTeach impulse project [2] for a hybrid teaching and learning environment for virtual product development, important results were developed, implemented in software and evaluated in order to achieve this goal (see Figure 1). Against this



background, the following goals were defined for the hybrid teaching and learning environment:

- coordinated, modular and didactically well-prepared multimedia material with targeted inclusion of external sources for flexible, individualized self-study learning
- balanced combination of macro and micro learning units
- project-oriented learning with the integration and, if necessary, networking of concrete CAx tools to promote the understanding and consolidation of what has been learned
- continuous review of acquired competencies through software-supported direct feedback in self-testing, for maturity measurement and in the sense of benchmarking/performance comparison via student group work (quality circles, project groups, etc.) up to moderated plenary sessions of the teachers
- testing adapted to the competence level through the use of different forms of testing (avoiding bulimic learning as test preparation) and the use of bonus performances
- according to requirements, alternation between self-study, work in student groups (also in the form of focus groups) and consultations with lecturers, e.g. in plenary sessions, on the basis of the developed project contents (inverted classroom) as well as targeted guidance and control by lecturers.

THE IDEA

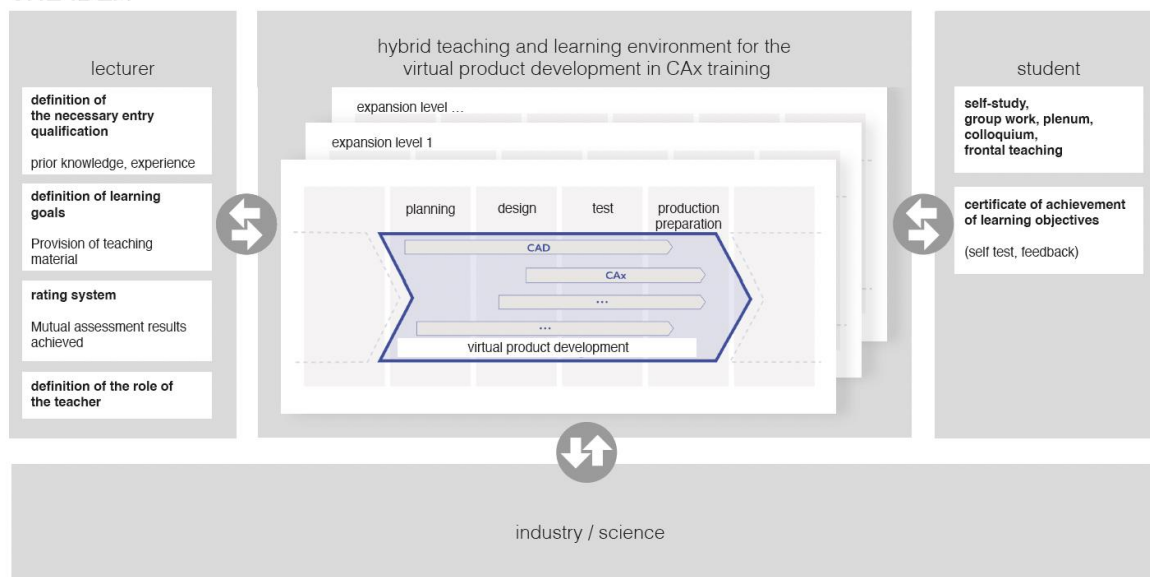


Figure 1 Hybrid teaching and learning environment

2. CONCEPT

The concept is based on different competence levels that build on each other didactically (see Figure 2). These enable primarily competence-oriented learning. Each level consists of several modules on thematically related topics (see Figure 3). Individual entry into the modules is also possible for students who already have the necessary skills. The modules always end with a final test. This can be evaluated together with the teachers.

The modules themselves are made up of lessons in which detailed topics are covered (see Figure 4). In accordance with the project objectives, each lesson contains a superordinate task element. These elements complement each other across multiple lessons. For the processing of a task within a lesson, there is a subdivision into input, process and output parts. In the input part, the specific subtask is introduced and explained. For this purpose, teaching materials and, if

necessary, output models are provided. The actual processing of the lessons takes place in the process part. In the output part, the students can check their acquired competences by means of a self-test. Depending on the results of the self-test, the next lesson can be started.

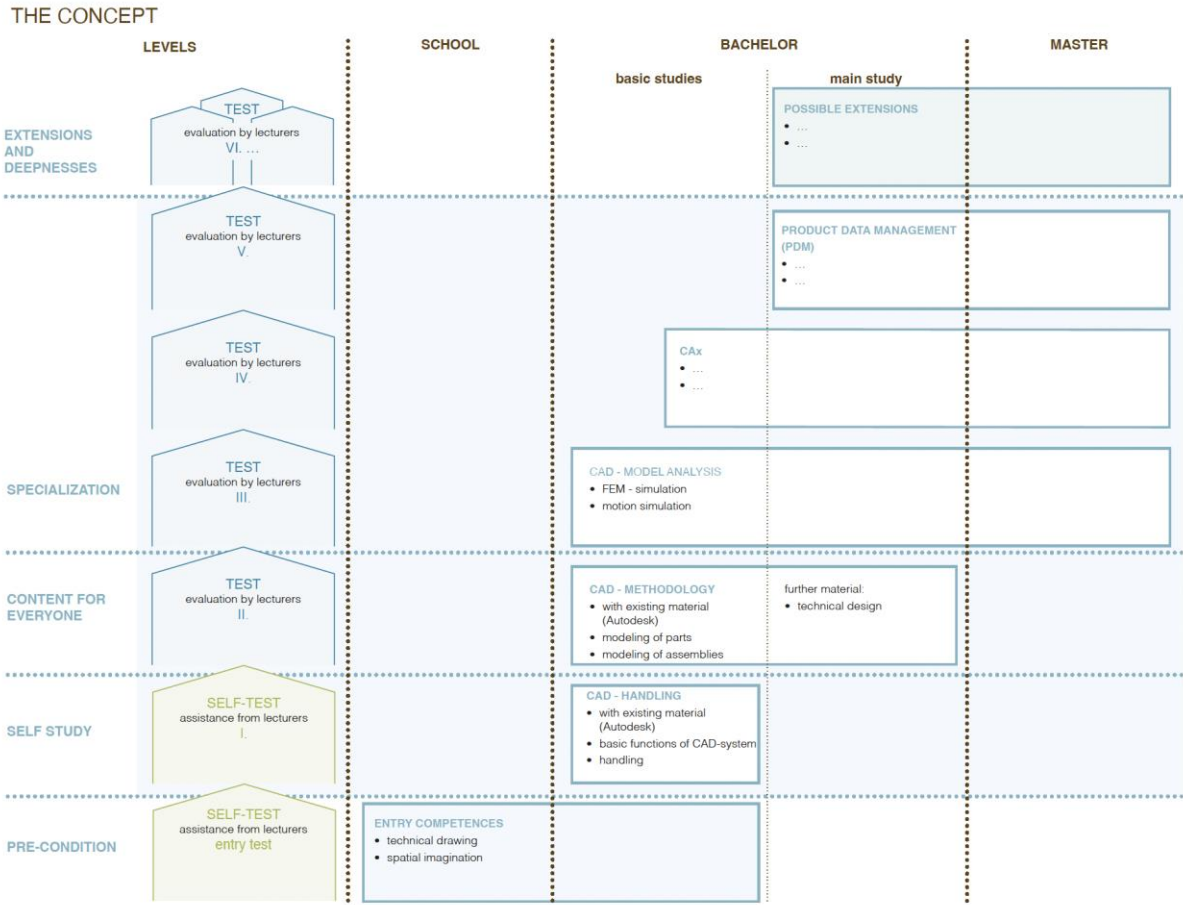


Figure 2 Overall concept

THE LEVEL

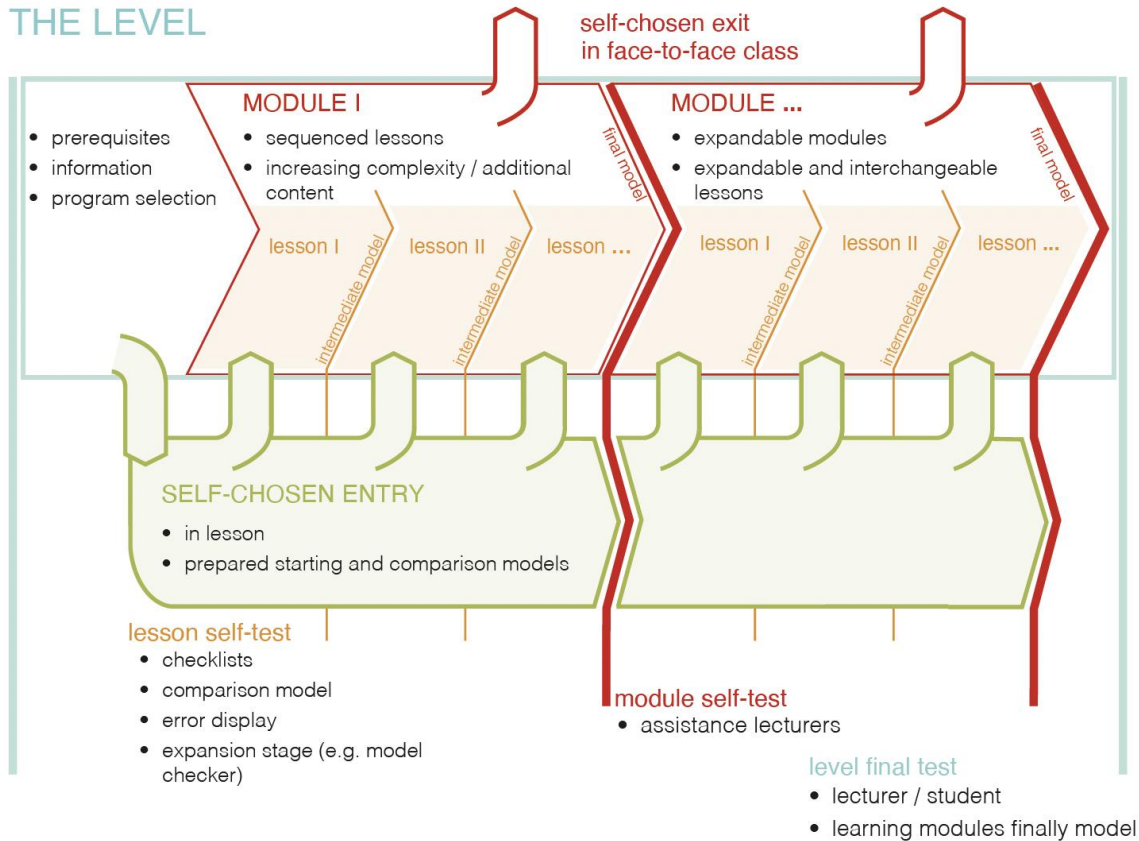


Figure 3 Module structure per level

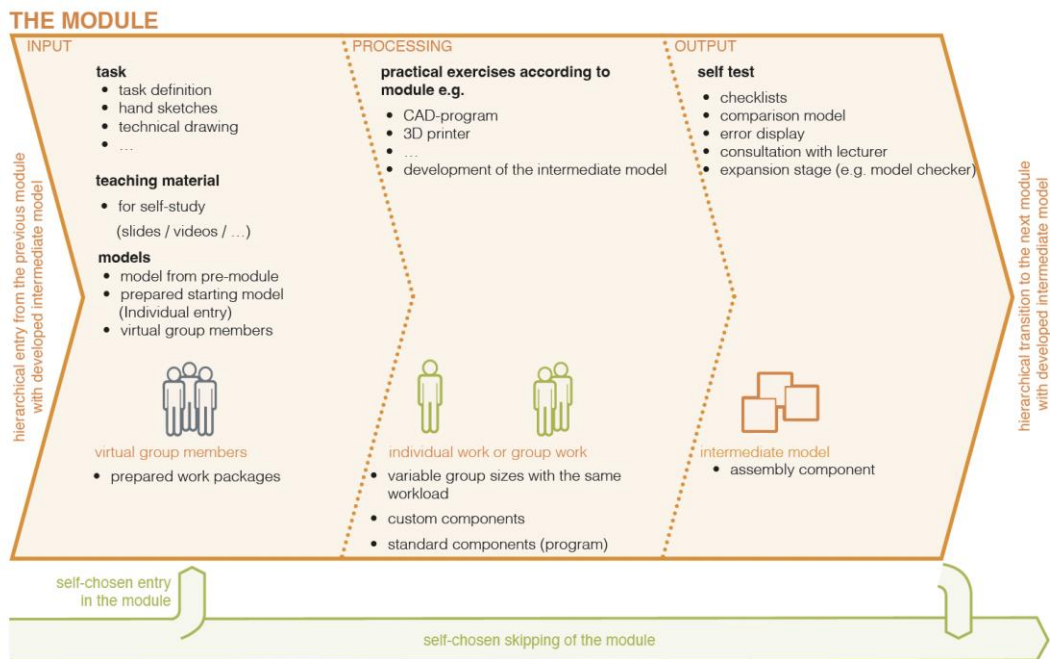


Figure 4 Structure of the lessons

The academic goal of an education in the environment of Virtual Product Development is to build up competence in CAD methodology [3], i.e. in the systematic creation of CAD models taking into account necessary follow-up activities (e.g. simulations, production preparation,

etc.) or necessary model modifications. Before students can build the CAD competencies, basic competencies must first be developed. The acquisition of competencies is reflected in the levels. Since students bring different initial competencies with them, they are first brought to the initial competency level that is relevant to them in Level 1. The goal of this first level is to acquire competencies that are required before using models and tools. These include spatial imagination, freehand drawing and technical drawing (see Figure 5).

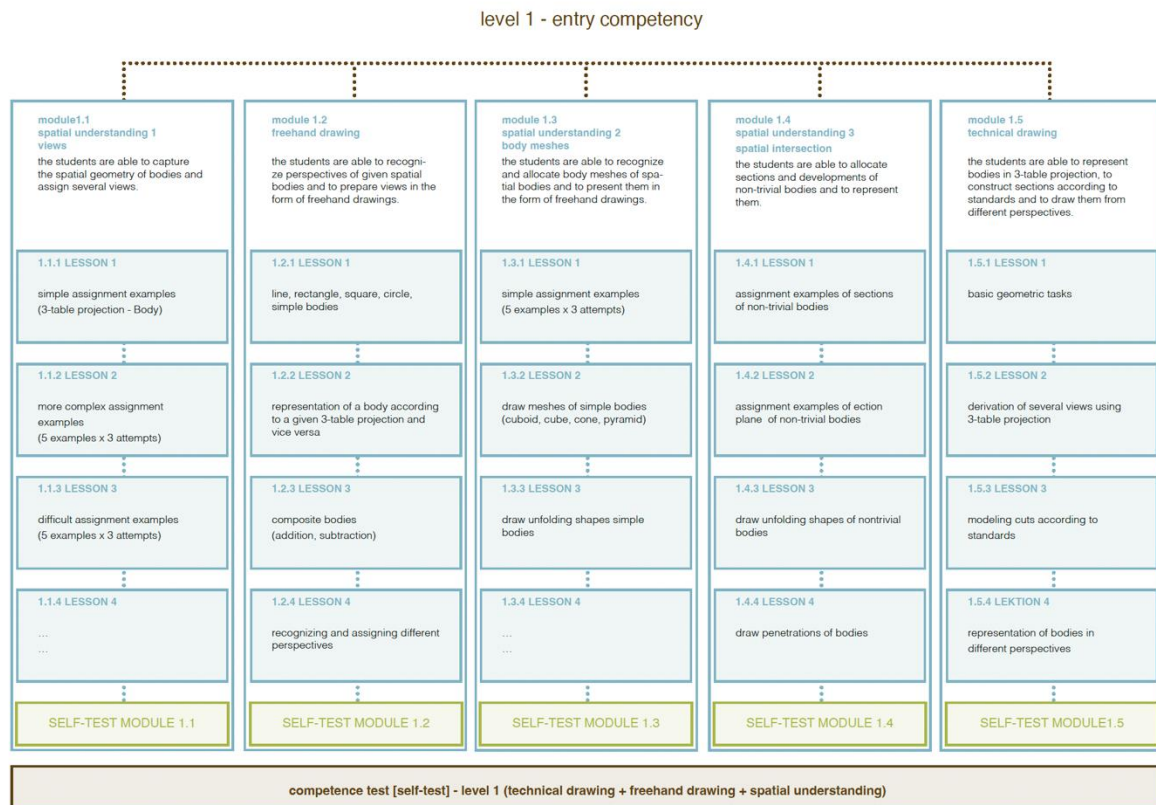


Figure 5 Content level 1 (implemented in moodle course)

Level 2 teaches the basics of operating the CAD system (see Figure 6). Simple models (individual parts and assemblies) are created. Level 3 deals with concrete approaches for building CAD models for specific applications (see Figure 7). The focus is on parametric models for change design and variant creation. Further use cases are described in other modules, which are also the subject of corresponding project-based tests.

level 2 - program operation

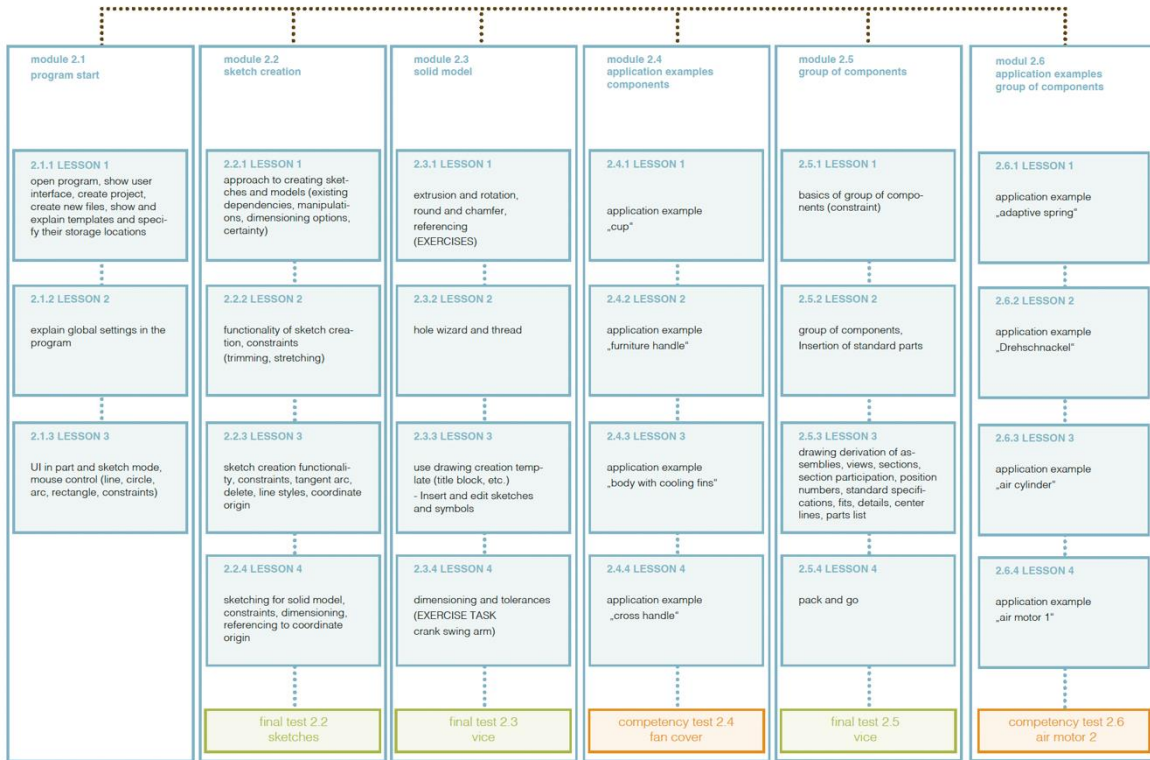


Figure 6 Content level 2 (implemented in moodle course)

level 3 - CAD methodology

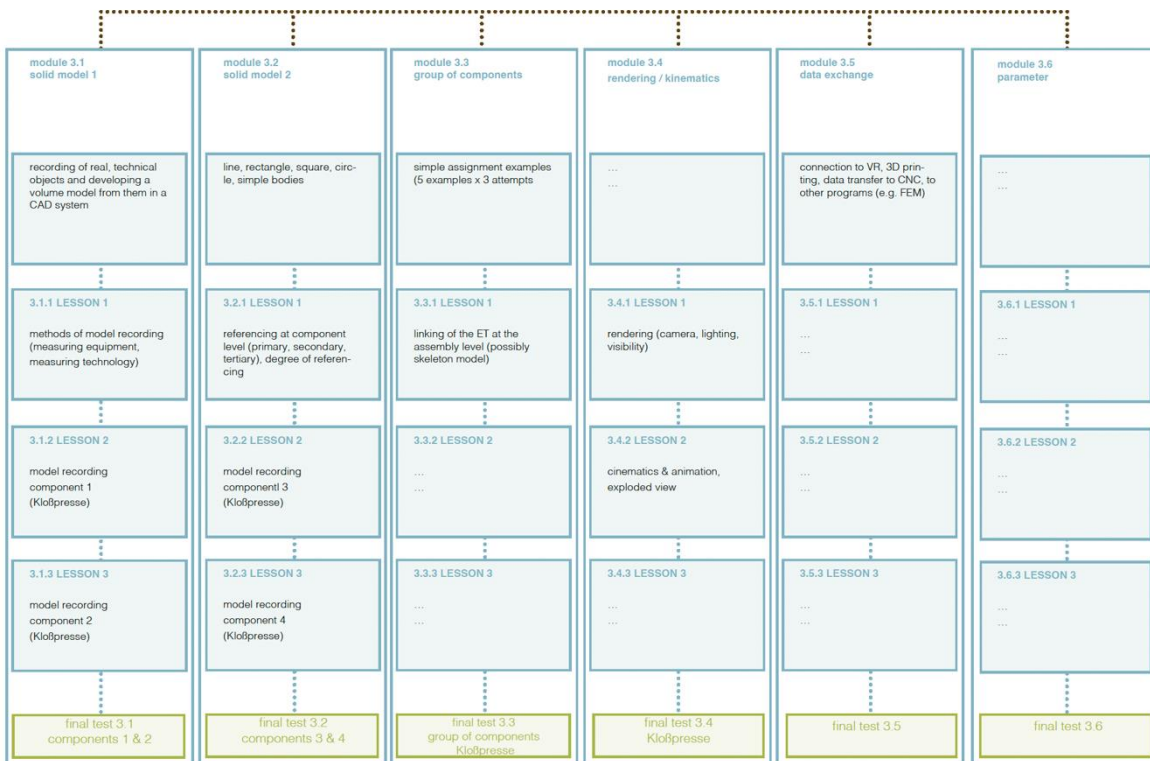


Figure 7 Content level 3 (implemented proportionally in the moodle course)

3. IMPLEMENTATION

The concept was prototypically implemented on the moodle platform of Nordhausen University of Applied Sciences (level 1 – 3 – see Figure 8). This allowed easy access for students from Nordhausen and as guests from the TU Ilmenau for the evaluation. After the evaluation, the teaching and learning environment was transferred to a Thuringia-wide moodle environment so that it can be used for all Thuringian universities (<https://virtueller-campus-thueringen.de/>).

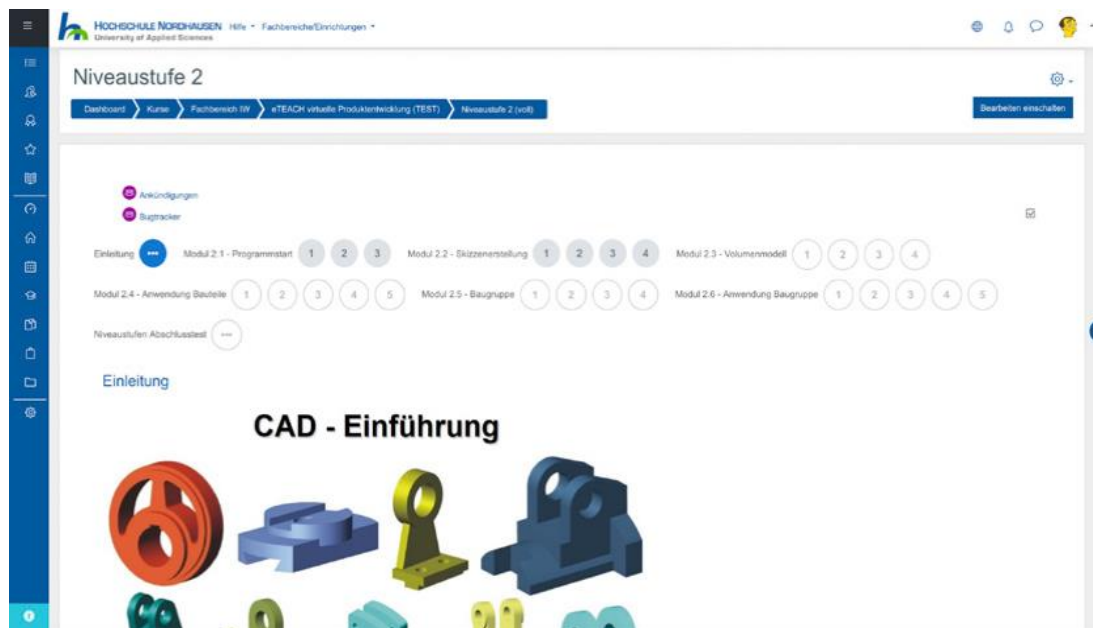


Figure 8 Moodle implementation

4. EVALUATION AND FURTHER ACTIVITIES

The concept was implemented on the moodle platform. To evaluate the concept and the first implementation, student groups with different initial competencies and boundary conditions were included (regular students of the CAD course without prior CAD knowledge, repeaters of the CAD course, experienced students who have already successfully completed the CAD course). Continuous evaluation of the course also allows for targeted assessment and adjustment of teacher involvement. The extremely positive results of the eTeach project indicate that the lessons learned should be fully implemented in a consecutive course of study. Further concrete activities concern the extension of the platform use for further courses of studies and universities. In addition, further CAD systems are to be integrated into the teaching materials. The experiences from the project will be used across the board to improve the competence-oriented testing of synthesis skills, which play an essential role in engineering education.

5. CONCLUSION AND NEXT STEPS

The successful results show that the results should be fully applied in consecutive teaching. The transfer is initially aimed at teaching CAD in the 1st and 2nd semesters at the TU Ilmenau and HS Nordhausen (affects students of different engineering degree programmes). Challenges arise mainly in the different moodle environments and due to the necessary adaptability to the different study and examination regulations. Addressing these open issues is the focus of the planned follow-up activities.

6. ACKNOWLEDGEMENT

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