

ADVANCED INSTRUCTION: Facilitation of Individual Learning Processes in Large Groups

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Abstract

By supplying various combinations of advanced instructions and different forms of exercises individual learning processes within the impartation of basic knowledge can be activated and supported at best. The fundamentals of our class "Introduction to spatial-geometric cognition using CAD" are constructional inputs, which systematically induce the objectives amended by background knowledge of adequate depth. Instructions are supplied either online as videos and images from the lecture notes or during an in-class lecture. For the adaption to the computer different steps of exercises were developed according to the level of proficiency. These are to be solved by learning groups of four participants supporting one another.

I. INTRODUCTION

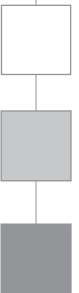
The presented didactic conception was developed to provide a compact, sophisticated and mainly successful access to spatial-geometric cognition for numerous first-year students in engineering sciences. For developing spatial cognition, CAD software and soft skills are applied, trained and encouraged as additional basic qualifications for studies at university.

Being an optional class at the beginning of the studies, it has to meet different basics

and capacities of participants to minimize the number of breakups at an early stage.

All attendants should be able to succeed – albeit through varying efforts - in the required level of proficiency at the ending of class (Rogers, 2006).

Out of many methods applied to the course this paper wants to enlighten the contribution of advanced instructions.



II. PREPARATION OF KNOWLEDGE



Figure 1. The Built Examples.

To substantiate the prepared themes and matters according to the objectives we chose several architectural and technical examples (see Figure 1). Thus a construction method was developed for either passing through all necessary and helpful facets, using the smartest and fastest road to success or presenting alternative approaches which are based upon didactics (Pütz, 2004).

The dealing with the contents is structured by considerations of the learning process instead of thematic taxonomy.

Processing appealing examples of extraordinary complexity serves the motivation of the attendants during a beginner's course. However, by a close description of all essential actions, with focused collaboration the participants are assured of feelings of success.

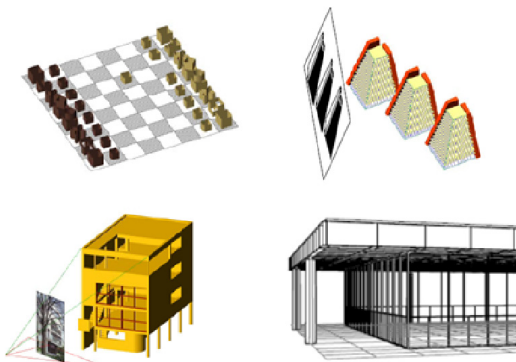


Figure 2. The CAD-Examples.

For teaching these contents detailed instructions for three examples are prepared in 8 lessons. Additional examples with similar background are offered for exercising in other levels of learning. Due to this multiplicity of examples the participants carry out different complex constructions during each lesson, by this clearly realizing their outcomes (see Figure 2).

For the different phases of exercise within the lessons four types of instructions with increasing detailing are devised. These correspond to useful action during the development of the working materials: selection of an example, collection of planning materials, definition of geometric structuring and complete documentation of software inputs.

a. Graphic Model - As a first work step the lecturer chooses a suitable example with which certain aspects can be presented (see Figure 3). Therefore he compiles comprehensive graphic documents, from which a transmission to the software can be realized

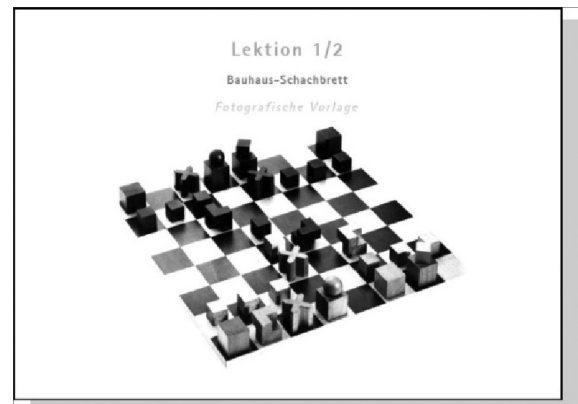


Figure 3. Graphic Model.

with this selection the lecturer already produces the documents for Level VIII (s. IVg.)

b. Plans with measurements - Succeeding, the lecturer carries out the example in useful planning material (see Figure 4). All measurements needed for transmission have

to be determined and revealed.

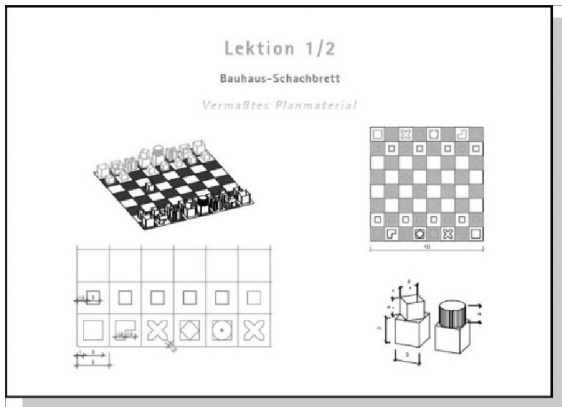


Figure 4. Plan with Measurements.

With these planning basics the lecturer defines material for Level VII (s. IVg.).

c. Geometric Structuring - Based on the determination of measurements the lecturer develops the geometric method as an instruction for later transmission to the software. Here the effort lies in defining the succession of separate construction steps (see Figure 5).

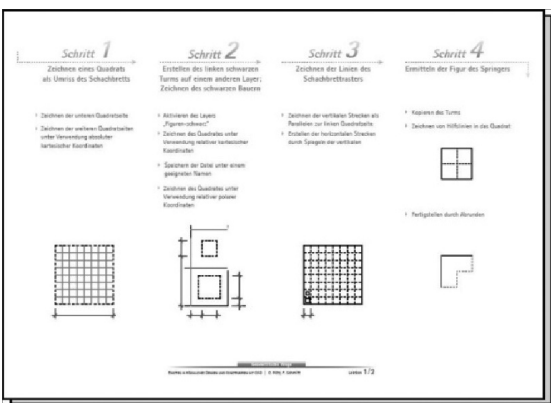


Figure 5. Geometric Structuring.

With the design of this structuring the lecturer receives material for Levels V and VI (s. IVe., IVf.).

d. Advanced Click-Instruction - Within the last work step the lecturer evolves the

transmission of the example to special software according to the formerly determined geometric method (see Figure 6). By this, different aspects of the program are worked over step by step. Each input is documented in this process. In addition, alternatives for commands and methods should be proposed and geometric backgrounds should be commented on. This will require most of the work for the development of the course program .

The click-instruction is the basis for the different types of instructions. These serve as models for the learner in Level I-IV (s. IVa. – IVd.).

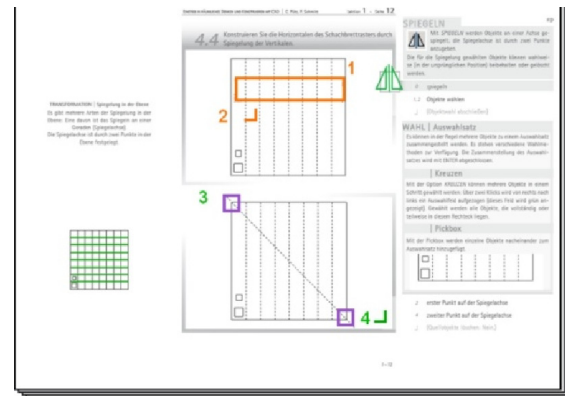


Figure 6. Advanced Click-Instruction.

III. DIFFERENT TYPES OF INSTRUCTIONS

The enhanced construction method is documented variedly for different educational programs retaining the principle contents and structures.

There are types which feature a direct execution without preparation and others which promote a first examination of the issues detached from software application. Latter indeed require more effort in time, but create a solid basic understanding and a long-term memory.

a. Video Presentation of Using Software

- The video presents all software inputs, which are needful for the construction method, on the screen as well as correlating (vocal) annotations. Every lesson is structured by around 12 sequences; viewing each prepares for own adaptation.

The lecturer can quickly produce this type of documentation by attending a pre-defined script. The learner is provided with a highly realistic idea of necessary actions (see Figure 7). Unlike a presentation with LCD projector during in-class exercise the participant can view a sequence at that time he himself is ready and focused, being able to pause, to repeat or to skip if required.

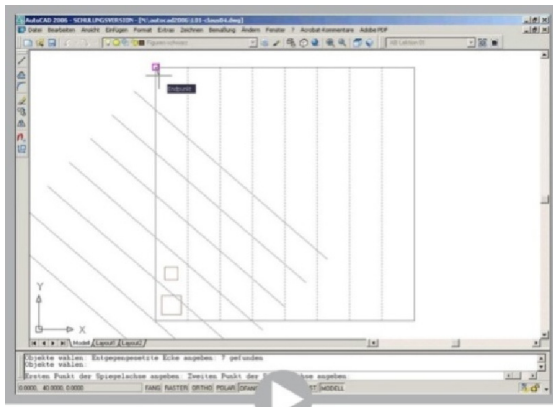


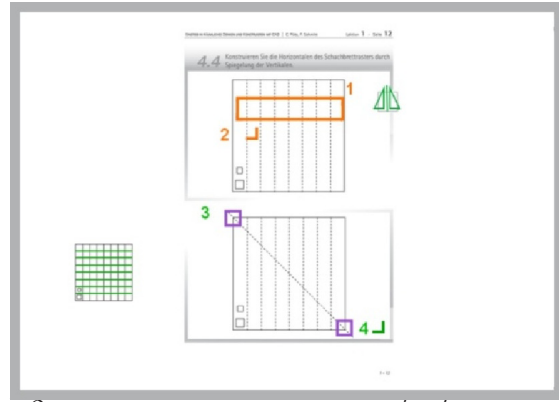
Figure 7. Video presentation of using software.

b. Colored Documentation of Inputs

- In this version the construction method is documented entirely with every point-and-click and all keyboard entries by colored records. (This can be recorded within the lecture notes, see below). Basing on a simple notation this creates a clear illustration of a command showing all necessary inputs within a single image; the abstraction simplifies the detection of central principles. Underlying phenomena are assigned to actions by different colorings (e.g. purple for coordinates). With this colored documentation the learner can quickly look at all needful inputs of a command (see Figure 8).

The access to information is much faster

than by viewing a video presentation of using the software; a print-out is considerably advantageous to a display on screen.



c. Book of Lecture Notes - The lecture notes present in detail several levels (see Figure 9): Within the left column on each page intermediate steps of the geometric method are documented in text and illustrations.

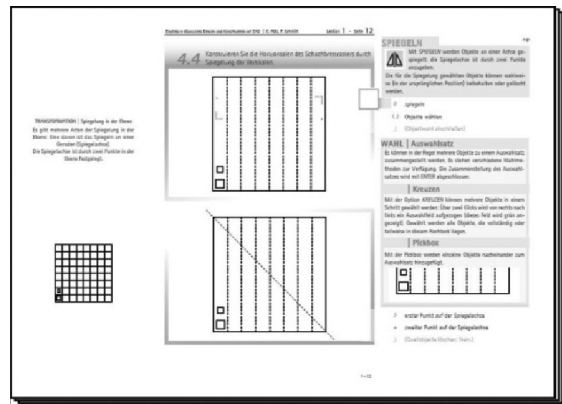


Figure 9. Book of Lecture Notes.

The drawings in the middle column represent the initial point for each appointed construction; here the colored records can be inserted. Thus the learner gains a great overview and quick access to all relevant information.

d. In-class Presentation - During the in-class presentation the construction method

is illustrated and at the same time recorded: the tutor filling in the vacancies in the lecture notes at the overhead, the attendants in their paper version in place (see Figure 10).



Figure 10. In-class Presentation.

According to experience, a high degree of concentration and a process of examination of subject matter is especially achieved by listening, viewing and acting at the same time. The collective experience of being in the same situation promotes hanging in there.

e. Completion of Lecture Notes via Video Presentation - Supported by the filmed and commented filling-in the learner can examine efficiently and independently the vantages of producing his own notes (see Figure 11).



Figure 11. Completion via Video Presentation.

IV. APPLICATION OF KNOWLEDGE

According to practical experience the application and examination of knowledge is structured in different levels of learning with adequate offers: During Level I to IV the learner revises the exercises according to the closely detailed instructions supplemented with background knowledge. One builds up his competence by experiencing and reflecting the actions. During V and VI he is merely supported by instructions reduced to geometric structuring. With VII to X the advanced learner can test the acquired independence from instructions.

a. Level I – First Examination of Subject

- A first occupation with subject matter is notably effective if the provided lecture notes are replenished in color while listening and viewing. Thus, a great number of students can be recruited for this activity.

b. Level II – First Application - The example is entered to the computer independently following the detailed instruction step by step, engrossing comprehension by reading the texts.

c. Level III – Discussion - An important component of our conception is to build learning groups of four participants each, within which problems and questions during application can be quickly solved. Mutual explaining accelerates and deepens the learning process, leads to extensive independence from support services and develops soft skills. Exercises, consisting of single components which are solved by each participant and finally added as one, even more strengthen the cohesion of the group. This two-way support can only be realized to some extent in the context of E-Learning e.g. by providing chat rooms.

d. Level IV – Efficient Application - To achieve confidence and routine in handling the program the example again is entered according to the detailed click-instruction,

as the multitude of newly introduced commands barely can be memorized within one run. With the gaps in comprehension being closed the repetition is considerably clearer and more effective hence reading and questioning is omitted.

e. Level V - Transfer - With each lesson an additional example comes along, on the basis of which the participant can reappraise and experience, what he has learned by “entering” according to the detailed instructions. The expenditure of time is restricted by a short instruction reduced to geometric structuring.

f. Level VI – Individual Implementation - Rehandling the complex example only by the means of the geometric method serves to reassure the already learned.

g. Level VII–X – Self-Developed Realization Competence is broadened further by solving other tasks (dimensioned plans, photos, textual settings, own designs). These are not covered by the optional pre-course.

Within Level VII the learner is provided only by plans with measurements, according to which he independently has to develop the geometric method and to transmit the example to the special software.

Self-developed realization of examples, only basing on the graphic material of Level VIII, is seen as final aim of the tutored phase of exercise. The advanced participant reexamines autonomously his comprehension of application for the program as well as for the illustrated geometric knowledge.

Subsequent additional steps for exercising can be provided with Level IX and X: Textual topics can open just as much space to the participant’s creativity as the realization of individual designs, which are tutored within the bounds of possibility.

V. INDIVIDUAL SUPPORT

Based on the instruction various categories of issues can be differentiated: careless mistakes during input, individual difficulties in comprehending single steps of construction, problems caused by accidentally changed program settings or issues uncoupled from the construction method.

Adequate support services are provided during in-class presentation by partners and tutors, during E-learning by help offers as well as online communication.

a. Self-Help - By repeating difficult passages the learner can specify certain issues, independently searching for their clarification in his completed lecture notes (see Figure 12).



Figure 12. Self-Help.

b. Learning Group - Individual weakness and strength are balanced within learning groups of 4 participants each (Cohn, 1997).

Problems, which cannot be independently cleared, can be discussed within the group and solved together (see Figure 13).



Figure 13. Learning Group.

c. Tutor - In each classroom up to 10 of these groups are supervised by one tutor. Problems, which cannot be checked within the group, can be discussed and solved with the tutor (see Figure 14).



Figure 14. Tutor.

d. Online-Support - In addition to the already mentioned web-based offers there are even more provided to support the clarification of problems: On our pages one can find “Frequent Input-Mistakes” and their explanations listed by appearance within the lectures.

Individual Problems can be described in the so-called “Forum”; there, the solutions should be developed and presented by other participants (see Figure 15). At a particular time these inputs are systematically worked over by a tutor.

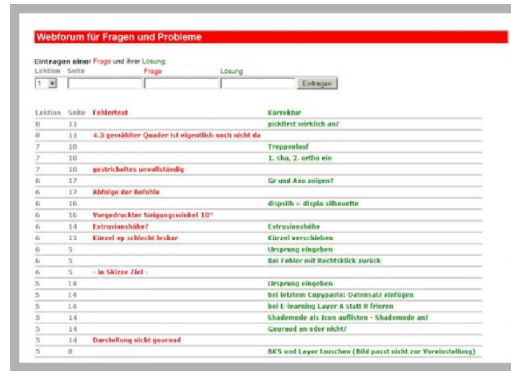


Figure 15. Online-Support.

VI. INDIVIDUAL LEARNING

Most favorable terms for learning are realized, if one can cut his own path according to originality, necessity and capacity. If so, a learner has to assume responsibility for his own learning process and to possess reasonable self-perception.

Our conception provides the participants with the possibility to use different offers during course of class, to evaluate personal experiences and to choose appropriate versions (see Figure 16).

The individual demand for support serves as objective criterion for the participant: If being high it is proposed to reoccupy with offers for knowledge transfer, which claim for more activity.

To hint at the range of ways in achieving the common purpose the “most popular”, the “most expeditious” and the “most efficient” variants are presented below.

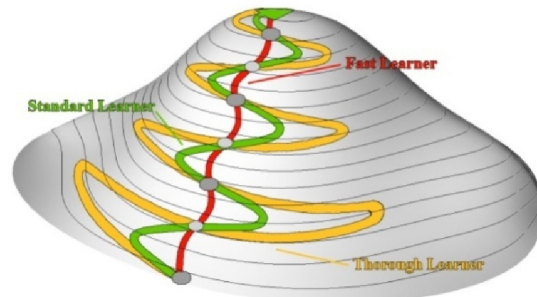


Figure 16. Different “Paths” of Learning.

a. Standard learner - For knowledge reception the “standard” participant attends the in-class presentation (90 min), finishes systematically all levels of learning (180 min - II 80, IV 50, V 20, and VI 30) and profits from the vantages of the learning group. To process all 8 lections like this one needs 48 teaching units (à 45 min).

b. Fast Learner - For knowledge reception the “fast” participant views the video presentation of using the software (45 min), skips Level II but finishes all further levels of learning (90 min - IV 45, V 15, VI 30) nearly without the need for individual support. To process all 8 lections like this one needs 24 teaching units.

A participant with previous knowledge reads the lecture notes (30 min) and finishes straight away Levels V and VI (each 15 min) within ca. 12 teaching units.

c. Thorough Learner - A participant, who demands for a very “thorough” education, attends all offers for knowledge reception (210 min), finishes the levels of learning by partly revising several times (270 min) and profits from individual support by learning partners as well as tutors. Thus one needs ca. 88 teaching units.

Very successful poll results, given by the students, demonstrate the high acceptance of our teaching method (see Figure 17). To us, a criterion of quality is met if the attendants are able to handle both the exercises and the transfer without support. To prosecute this claim we present the in-class exercises with 250 attendants: If – without support of the tutors - there are several participants within this practice lost upon the same step of the construction method, this passage is modified to prevent the following class from these problems.

In this way we also guarantee that even within E-learning the participants ever less hit snags. Another starting point for optimization is supplied by our online monitoring where the individual time need of each student is listed and which steps are improvable.

VIII. EXPENSE MANAGEMENT

The absolute separation of knowledge transfer from practical realization at the computer results in an exceedingly convenient cost-benefit ratio for the in-class course.

In spite of the great number of participants the lecturer only once has to present the contents in a lecture hall. The exercises take place at various times in different computer pools; 40 participants (10 learning groups of each 4 learners) can be well supported by one tutor. For the online offers, the costs are reduced to the expenditure for maintaining regularly the questions in the “forum”.

The considerable high effort in time and personnel for the development of the topics (s. II.), the realization of the instructions as well as the conception of further exercises amortise fast with the high number of participants being attained.

The available amount of money deter-

VII. QUALITY MANAGEMENT

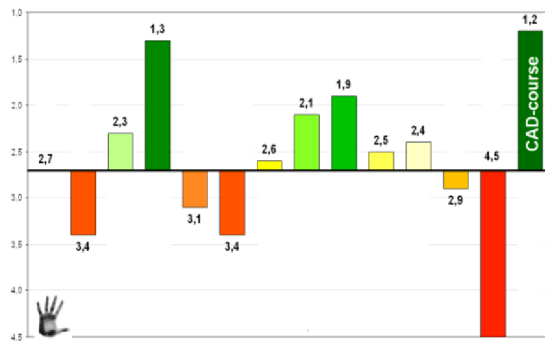


Figure 17. Poll Results at RWTH Aachen, 2006.

mines in which depth the program can be presented. By this, the different types of instructions (s. III.) can also be understood as expansion stages.

IX. TRANSLATION

The introduced course was verbalized in German for RWTH Aachen University. As stress is laid to the graphic conception, the course program can be translated into other languages with relatively low effort.

X. TRANSFER COURSES

As regards content the main achievement of this conception resulted in the development of a clear construction method; according to this basic principle transfer courses for fast access to other software were developed (see Figure 18).

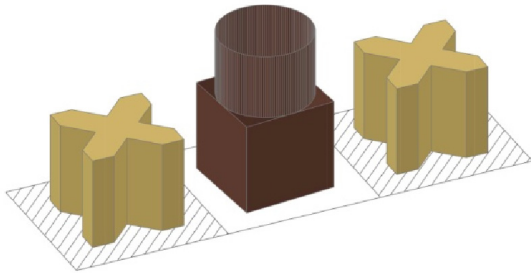


Figure 18. Fast Access Example for Other Software.

XI. RESUME

Differentiated forms of teaching and exercise based on constructional instructions can encourage individual learning: In achieving the same outcomes obviously it takes less time for students of high-capacity than for those without previous knowledge and more need for exercise.

During practice in this course program at RWTH Aachen University a great num-

ber of students accepted the in-class offers in particular, coping with difficulties easier this way.

XII. REFERENCES

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