Theory-based course design for professional Master´s degree program in Business Engineering

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Abstract—**The shortage of young engineers presents a structural problem that deflates growth and innovation and causes high value losses for the economy. To achieve sustainable success in securing new recruits, prospective students from working life are highly relevant for the universities, because they act at the crossroads of Engineering and Business. Although the offer of studying programs alongside work has grown in recent years in Germany, there is still a lack of theory-based development in didactic concepts for this specific studying group. Generally, there is still a need for research in context of accompanied studies and student-centered contact with the learning professionals.**

This paper aims to generate new insights in a threefold way: (1) by specifying challenges and approaches for accompanied studying programs in Business Engineering; (2) by explaining the theoretical framework for the methodical educational arrangement of exemplary engineering courses; and (3) by describing first experiences with the concept during the development and implementation in selected engineering courses. This generates empirically grounded knowledge on the theory-based course design for learning professionals and contributes the translation of pedagogical research to practice.

Keywords—design-based research; model of educational reconstruction; lifelong learning, employed learners, professional master´s degree in Engineering

I. Introduction

Germany is in possession of relatively few raw material resources, therefore economic success depends mainly on the innovative strength of companies. This requires highly-qualified specialists. On the one hand, the field of engineering science is confronted with a continuous increase in the demand for knowledge and skills. On the other hand, there is a massive shortage of skilled professionals, as in [1]. The shortage of young engineers presents a structural problem that deflates growth and innovation and causes high value losses for the economy. Efforts have been made by universities to attract new target groups (women among others) as well as prospective students from working life. The second mentioned are highly relevant because they act at the crossroads of Engineering and Business.

The opening of colleges for non-traditional students and the creation of new study programs, especially for learning professionals, is a key issue in educational policies, e.g. [2-4]. Universities in Germany ask "… to support and sustain divers segments of education for the various target groups", [3], and offer a growing number of studying programs for learning professionals.

In this context there is a constant need of research for accompanied studies, as in [5]. In particular, there is a lack of research on studying structures and on the didactic design of offers for this specific target group, see [6]. Furthermore, there is no theory-based development of targeted didactic concepts and associated empirical findings, [7].

This paper makes a contribution to this research discourse. With a focus on engineering science, it deals particularly with the theory-based course-design for experienced professionals who do not come from a technical field.

In section II, the challenges that universities are facing during the didactic design of further studying programs for working students are presented. Also, in this section, the methodology of this research-to-practice work is shown. Section III of this paper is about the model of educational reconstruction as a theoretical framework for a consistent student-centered conception and implementation of engineering lectures. The following sections IV and V are based on the educational reconstruction and concern the theory-based lecture scheme implemented in the masters' classes, "Applied Engineering Sciences" and "Actuators and Controls" as a contribution to the translation of pedagogical research to practice.

The final section VI outlines the results and the experience of the research-based course-design and shows future perspectives in this field. In this section, opportunities and challenges of accompanied studying programs in the field of engineering are described, as well as the close integration of university teaching, economics, and knowledge transfer.

II. Motivation and Targets

A. Challenges for the unviersities

Universities in Germany are mainly focused on the undergraduate study of traditional students. A major part of the provinces' expenditure is invested in research and the education at universities. The expenditures for further qualification and the maintenance of competences are comparatively low. Due to the demographic transformation into ageing societies and to the rapid pace of technological change, the European University Association recommended in 2008 in their preamble [8] for universities to open up to continuous education. The association attributes a key factor in this change process of European higher education to the universities. Furthermore, the change processes are seen as a source of new research methodologies and topics: ”Universities’ research and innovation mission can be strengthened through lifelong learning strategies, and universities’ specific contribution to lifelong learning should be underpinned by research”, [8].

Since then, German universities have followed this central educational objective of opening up universities to lifelong learning more intensively. Some have discovered this continuing education as an important profile topic. Thus, flexible learning pathways are supported that then counteract the skill shortage described in the introduction, as in [4]. The appropriate way of dealing with this non-traditional type of student is a particular challenge for universities. The group of lifelong learners in its entirety is very heterogeneous. A demarcation and differentiation is made in [9]:

- Late learners, e.g. adult students at the age of 25 and over
- Vocational learners, e.g. those with vocational education or with work experience before entering university
- Alternative learners, e.g. those studying in study formats different from contact study
- Employed learners, e.g. those working full or part time during their studies.

This paper focuses on the last group, the employed learners. They show “…circumstantial diversity with age differences, disabilities, employment status, caring responsibilities or different financial backgrounds” [10]. And additionally, a diversity regarding their motivation, interest, and learning styles, [ibid]. To meet this target group of employed learners a cultural change at German universities is necessary as well as a student-centered design of the offered study programs, [6]. Also, there is a lack of didactic concepts, theory-based development, and empirical findings in this area [7]. This contribution dedicates to this research desiderate.

B. *Implication to practice: Professional master’s degree program in Business engineering - objectives for theory-based course design*

The focus of the implication to practice in this contribution is on the crossroads of engineering and business. Table I provides a general overview of the occupational study programs that are offered for employed learners. Of these offered study programs, 13 are the master’s degree in business engineering, which build the focus of this paper.

TABLE I. OVERVIEW OF OCCUPATIONAL STUDY PROGRAMS IN GERMANY

Occupational study programs in Germany[a]			
Number of study programs (all disciplines)	***Number of engineering study programs (from architecture to economical engineer)***	***Of them the number of master programs***	***Of them the number of business engineering***
1100 (bachelor and master degree)	250 (bachelor and master degree)	132	13

a. Own research by http://www.hochschulkompass.de (Online platform providing an overview of study programs in Germany, survey date 03/29/2016)

This brings up the challenge of linking engineering disciplines with processes and contents of professional practice. The design of the curriculum and the design of individual courses have to meet the individual learning process of the employed learners and their conceptual development. As an example, the theory-based didactic design of the two master classes “Applied Engineering Sciences” and “Actuators and Controls” are presented in this paper. These classes are embedded in a business engineering master’s degree that is scheduled on the weekend. It is a four term (90 credit points) extra-occupational study program combining engineering content with business specialization. As a specific feature, the master’s program is designed for non-technicians. This Master of Science program is now in its third iteration. The courses are designed with a focus on industrial production, combining the complex links between technology, business, and management. In the first semester scientific and engineering fundamentals are taught. The second and third semester include more detailed engineering courses as well as more complex topics that deal with the connection between technical and economic content. Throughout the entire study period, complementary courses are offered that accompany the study (for example courses in leadership). In summary, the program consists of:

- Scientific and engineering fundamentals
- More detailed engineering courses
- Process-oriented courses
- Multidisciplinary courses
- Master thesis

The two courses presented exemplarily in this paper to explain the theory-based course design are from the field of scientific and engineering fundamentals.

C. *Methodology of the research-to-practice contribution*

“Methodology can be seen as the strategy, the plan of action, process or design lying behind the choice and use of particular methods and linking a choice and the use of methods to the desired outcomes”, [11]. For a successful completion of the research question, it is necessary to clarify the connection between the research objectives and the selected methodology. The research objectives in this paper stand for both theoretical understanding and educational practice. In order *to design and to study* within the same research process, see [12], design based research was chosen. Design based research is a multi-faceted approach that "...can yield valuable results for both theoretical understanding and educational practice" [ibid.]. The generic model for educational design research is shown in fig.1. Furthermore, this methodology has been used because the main stages of the research interact with the educational practice. In this way the research objective by dual outputs of innovative approaches and theoretical findings was achieved.

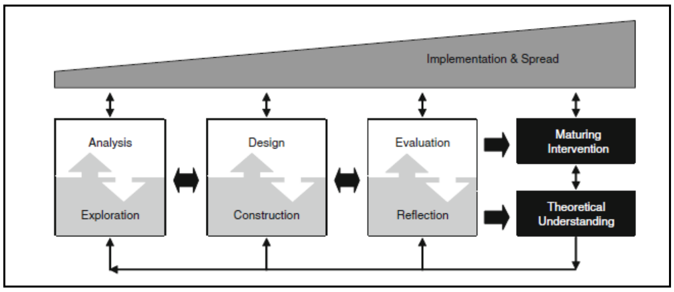

Fig. 1. Generic model for conducting educational design research, [13]

All three stages of the process model for the design based research (Analysis, Design and Evaluation) are implemented in the research process. Within the analysis phase the theoretical framework is prepared, see section III. Guided by the model of educational reconstruction, the conception of the lectures and the methodic-didactic design are explained. The implementation in the master program as a contribution to the translation of pedagogical research to practice will be presented using the example of the courses, "Applied Engineering Sciences" and "Actuators and Controls". This *design* stage of the design-based research process (section IV and V) is followed by the *evaluation* process. A self-rating assessment of learning success of the students and their feedback about the lectures, provide empirical data about the success of implementation. First experiences with the existing groups are presented in this paper, as well as the challenges that have arisen while implementing the lectures.

III. THE MODEL OF EDUCATIONAL RECONSTRUCTION

This paper represents the model of educational reconstruction as a theoretical framework for a consistent student-centered conception and implementation of engineering lectures for experienced professionals, who do not come from a technical field. Starting from this theory framework, the paper contributes to a theoretical under-standing and educational practice of engineering courses designed for a specific group of students at the crossroads of engineering education and business.

A. The model of educational reconstruction in general

The model of educational reconstruction is a research framework that is widely used in scientific education, as in [14, 15]. It is still common in engineering science to base the teaching on technical matters. Other aspects like the teaching objective or the perspective of the learners are often only dealt with secondary. To counter this imbalance in the didactic work and to take the students as an active starting point for the construction of knowledge seriously, the model of educational reconstruction could be a major help, see [16].

In the model of educational reconstruction, scientific concepts and the perspective of the learners are related to each other. A conclusion about the design of student-centered learning environment is drawn from the comparison. This is particularly important for the didactic construction of professional master's degree courses. Besides the specifics of the employed learners, outlined in section II of this contribution, the challenge exists that the majority of students are new to the field and not familiar with it. Therefore, it can be concluded that teaching content may not simply be dictated in a scientific manner but have to be "created" in a pedagogically useful manner through the conception of the learners themselves, [16]. By constructing teaching content in this manner, there are three elements that interact. They can be described by the teaching methodology triplet: the detection of students' perspectives, the clarification of experts' conceptions, and the didactical structuring. Fig. 2 shows the interaction.

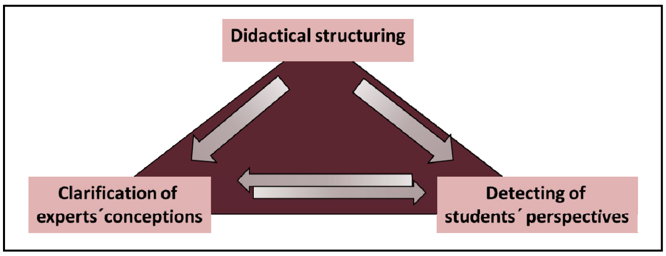

Fig. 2. Didactical triplet, own figure based on [16, p.4]

The unique characteristic of this triplet is the equivalence of experts' conceptions and students' perspective**s**. This assumption is based on the theoretical framework of constructivist learning theories. Constructivist approaches are characterized by the priority of actively construing by the learner, e.g. in [17]. Here, the process of learning means the structuring and evaluation of existing ideas as well as the formation of new technical-orientated content. It is about using the existing concepts as a starting point for designing the learning process and building on them instead of just replacing existing ideas that are rated wrong from a theoretical point of view with the "right" idea, [16].

B. Research process with focus on engineering sciences and employed learners

The author has differentiated this research framework for the implementation in engineering science. There are first results concerning the implementation of this adopted model, [18]. As a novelty in this paper, the model of educational reconstruction will be implemented with a focus on employed learners. From the students' understanding of engineering basics of this particular group of students, a theoretical guided concept of two lectures in the engineering master's program is derived. Fig. 3 shows the generic model adapted for the field of engineering sciences and employed learners.

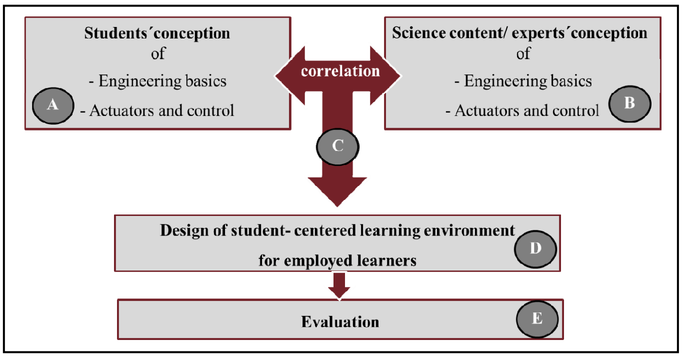

Fig. 3. Model of Educational Reconstruction with focus on engineering basics and employed learners, based on [18]

To implement the model, the research steps A to E must be completed. The model in all its sequences provides research data that is used for the consistent implementation of study-centered education for employed learners in engineering. In the following, these will be described in detail.

Firstly, the students' conceptions about electro- technical concepts must be collected (**step A** in fig. 3). Then, the experience the students have with technical concepts must be evaluated. What picture do they have about these concepts and where do they make connections between the theoretical concept and the practical implementation? At the same time, the scientific clarification is being prepared in **step B**. What do the concepts look like in science? What scientific models exist and where can coherences and limits of the imagination be found? The technical clarification identifies the similarities and the differences of the experts' conceptions and determines which theories they are based on. In **step C**, the learners' understanding about the technical theory is reflected. In this way**,** differences between scientific perspectives and the perspectives of the learners are disclosed. Are there existing correspondences to the scientific model? At which point can you build on the learners' conceptions? As a result of this correlation, research-based findings exist that prescribe what has to be regarded while introducing terms, concepts, and models to the students. Furthermore, with the goal of fostering the students' learning process, the result of the correlation proposes the appropriate interventions that are most likely to be successful. These interventions will be developed in correspondence to the framework of constructivist learning theories and implemented in an engineering teaching practice in **step D**. A final evaluation (**step E**) delivers empirical evidence about the effectiveness of the interventions.

C. Methods used

In order to grasp the variety of aspects in a scientific manner, quantitative and qualitative research methods are used. These are shown in an overview according to the research steps A to E, fig. 3.

Collection of students' conceptions (step A): The learners' understandings of engineering basics are collected by students' self-report. Besides socio-demographic data, motivation to study, and background on technical subjects, the report contains questions for the employed learners about the current conception of engineering basics and actuators and control. Additionally, the answers are compared with the findings of a quantitative study that is about the collection of traditional students' conception of engineering basics, [18].

Science content/ experts' conception and correlation (fig.3 step B, C): The scientific key concepts have been identified and analyzed from the literature, e.g. [19- 23]. In addition, they have been connected to the interpretation of the students' conceptions.

Design of student-centered learning environment (Fig.3 step D): The findings of the analysis phase (A to C) lead to the theory-based development of a student-centered didactic learning concept. This design phase is presented in part IV. Further influences are theoretical frameworks such as constructivist learning theories, e.g. [17, 24], and gender theories focusing on STEM education, e.g. [25- 27].

The evaluation (*Fig.3 step E)* To evaluate the effectiveness of the courses, the students' self-reports on knowledge base within the engineering topics have been repeated at the end of the semester and compared to the survey that was conducted at the beginning of the semester. Existing research data from the last two years in the "Applied Engineering Sciences" course will be used in the evaluation of a pre-post comparison. Further feedback from the students has been incorporated into the process of improvement of the course design.

IV. Research- and Theory-based course design

As described in section IIb, the challenge in course design for professional study programs exists in the linking of the course's technical content, and the processes and content from professional practice. This is connected with higher efforts in didactic and methodological design of each course. How the model of educational reconstruction can be used successfully in the theory-based course design, is described below exemplary by using the two examples.

A. Objectives and required learning outcomes of the courses offered

This paper focuses on two fundamental engineering courses: the first semester course "Applied Engineering Science" and the second semester course "Automation – part actuators and controls". Both pursue the objective of building, strengthening, and expanding technical knowledge, analytical skills, and scientific expertise. Tab. II gives an overview of the learning objectives and required learning outcomes of both courses.

TABLE II. Required learning outcomes of the two examplary course

Brief overview of required learning outcomes	
Master module (semester)	***Content and required learning outcomes***
Applied Engineering Sciences (1)	The module provides the engineering basis for further specialist modules. It covers the fundamentals of electrical engineering (DC and AC voltage technology), electronics and mechanical engineering. Required outcomes are: • developing technical-methodological skills (basic techniques and engineering practices in

Brief overview of required learning outcomes	
Master module (semester)	***Content and required learning outcomes***
	the handling of simple electrical and mechanical problems, structured procedures, careful selection and use typical technical methods) • developing practical knowledge and basic skills (for example the analysis and the implementation of equivalent circuits, the use of appropriate measuring methods, handling of common measuring instruments).
Automation-part actuators and controls (2)	Required outcomes are: • technical-methodological expertise in the field of actuators and controls (basic techniques and engineering practices in the handling of typical exercises from this field) • professional practical knowledge and basic skills in the use of appropriate measurement and analysis procedures.

How can the learning outcomes be improved through a precisely fitting course design?

B. Analysis of students' conception

The answer to this question will be preceded by an analysis of the students' conception of engineering topics. From this analysis, guidelines for the design of student-centered learning environment are deducted. The analysis of the socio-demographical data revealed an extremely wide spread in every evaluated category. These findings were to be expected and are consistent with the research findings about employed learners, [10], that are mentioned in section IIb. The age varies between 23 and 43. As of yet, 20 percent of the students are female. The professional position ranges from the self-employed to leading positions in the industry. Employers are small companies as well as global companies (e.g. automotive industry and energy industry). Every participating student has a bachelor degree. The students had to self-report their technical background in Engineering Science on a scale from 1 (no technical background) to 10 (detailed technical background). In conclusion, the technical background was rated low. The detailed findings of the survey on the technical background are shown in Fig. 4 in section V. A comparison with a survey on traditional first semester bachelor students, [18], provides further insights. On the one hand, the self-rated backgrounds are similarly low. For some employed learners the education took place a long time ago. On the other hand, employed learners have expanded professional and everyday experience. This extended experience is not yet actively retrieved by the student as transfer knowledge. Thus, the majority of the students report experiences with losses that are described by the student (e.g. in industrial plant or in economy system). The link to the field of engineering (e.g. losses of a real electrical source) cannot be made yet. Referring to the model of educational reconstruction, these students' conceptions must be incorporated actively in the student-centered course design, to achieve an individual and optimal adoption for the best possible learning outcome and the development of the students' professional competence.

C. Derived guidelines conception and design

The methodological-didactic design of the courses is based on the theoretical framework of constructivist learning theories and motivation, e.g. [17, 24], further theoretical frameworks are gender theories focusing on STEM education, e.g. [25- 27]. In looking at all these theories, we see the requirements for embedding the engineering topic stronger in active approach. Another important demand is a stronger link between theory and practice. A particularity of these professional courses is the relatively small number of students. This opens up additional possibilities for the course design. Other type of events can be considered that are not practicable in traditional studies, due to the limitations of lager groups. Of particular note is the one-to-one tutoring approach of Bloom, [28]. His investigations of different learning performances have shown that this tutoring is the most effective instruction method. Although this method is "… too costly for most societies to bear on a large scale", comparable approaches may result in a similar improvement, [ibid].

Besides these theoretical frameworks, the analysis of the educational reconstruction has shown that the methodological-didactic construction of the courses needs to be understood consequentially from the learning process of the individual. The fundamentals of the specific field should always be presented with a focus on taking up the professional context. And the integration of practical and professional relations should be strengthened. It is important to actively search for connections to the actual working sphere of the employed learners or rather, to ask the students to specifically look for examples from their own working sphere. Furthermore, the links to other fields of science should be reinforced. For the master of engineering, the link to economic and sustainable topics is particularly important. By the deepened and special confrontation with problems in the fields of engineering and economics, the understanding of complex relations as well as innovative action is supported and expected at the same time.

The mentioned directives are anchored in the didactic concept of the two courses described. As part of the course, instructional settings are offered that implement these directives and thus straighten the concept development of the employed learners. The derived teaching learning forms are:

- *Lectures* as on-site-events with practical examples selected from priority themes (presented by the teacher or the students)
- *Laboratory sequences* integrated into the lectures to anchor the link between theory and practice (laboratory tests about priority topics with the goal of achieving a strong connection between theory and practice by hands-on experience, explained in detail in section V)
- *Guided self-study* with reflection and feedback phases (conception of exercises for this particular target group with temporal and personal restrictions, self-control must be possible permanently, therefore step by step conception of the exercise. Online part with the teacher to reflect the professional concept development of the student)

The guidelines and directives described in this section build the basis of a theory-based course design to support the employed students' learning process and guarantee appropriate learning activities for the students.

V. IMPLEMENTATION AND FIRST FINDINGS

The implementation of the educational reconstruction in the master's program is presented using the two courses, "Applied Engineering Sciences" and "Actuators and Controls". Both courses are currently running in their third iteration, and both courses are taught by the author who has already collected experience with the educational reconstruction in undergraduate studies, [18]. These experiences as well as the small group size were beneficial for the implementation of the research framework.

A. Example courses

The innovative teaching and learning approaches derived in section IVc, are introduced in detail. In particular, the teaching and learning forms "lab sequences" and "guided self-study times" are described.

1) Integration of an experimental phase:
The laboratory experiments were integrated in both engineering modules in order to overcome the specific deficits in practical preliminary knowledge. These deficits were revealed in the analysis of the students' conceptions. The goal is to reinforce students' competence in the technical and practical field, as well as the integration of teamwork and active learning.

In contrast to traditional approaches the laboratory session is often the starting point of the lessons. This specific modification of the course design is driven by the theoretical framework. Based on the practical experiences, the theoretical background will be developed. This procedure enables to address the unique deficiencies and baseline knowledge of the target audience. By the small number of students an individual support of the learning process is possible.

The practical experiments were developed and adapted to the core statements of the course. Table III shows a short overview of the necessary steps.

TABLE III. IMPLEMENTATION OF ON-SITE LABORATORY EXPERIMENTS

Step	Content
1	**Preparation:** Generation of laboratory experiments with concrete orientation on the contents of any given course. Providing experiment documentation, manuals and further theoretical explanations.
2	**Conducting the experiments:** Individual performance of laboratory tasks in each workgroup of two students separately, and in so doing generation of on-site Laboratory Experiences. Linking the courses' contents to concrete practical tasks. Hands-on use of measurement instruments and laboratory equipment.
3	**Feedback:** Disclosing individual problems of understanding and quick feedback on the actual state of performance while the experiment is being performed. Possibility of reflection and just in time reaction to performance deficits (for students as well as for the teacher).
Continuous monitoring and support by the teacher	

In order to create the connection between theory and practice, the didactic target was to "do it yourself". In the *experimental phase* the employed students work out technical contents, that are derived from the occurrence of new practical problems (table IV shows a brief description of content and methodology of two exemplary experiments). They work within the didactic chain, starting with the problem definition, over the idea-knowledge-exploration, towards a solution proposal and final synthesis, and therefore increase their technical proficiency. Within laboratory group work, a continuous self-control of the students is applied and technical and methodical questions arise. Technical support is offered during the experiments, so the students can work out their necessary technical and methodical competencies.

Since learning is a social interaction, collaborative learning [29] is a column of the experimental phase, that addresses individual work and team work in the same way. Tab. IV gives a short overview of one exemplary experiment from each module.

TABLE IV. BRIEF DESCRIPTION OF EXEMPLARY EXPERIMENTS

Name of the experiment/ module	Content	Practical skills and methodological competences
Electrical measuring instruments and basic electric circuit / "Applied Engineering Sciences"	Overview of commonly used measuring devices (getting started, operation, performance conditions, specifications). Fundamentals of circuit analysis are covered, typical circuit characteristics, performance tests of a variety of sources.	Introduction to electrical-engineering fundamentals, electrical circuit analysis; principles and applications of measurement technology and electronics; systematic troubleshooting; basic concepts to show students how the principles of electrical engineering apply to specific problems in their own fields; enhancing the overall learning process.
PID controller / "Automation - part actuators and controls"	Tuning a PID controller by systematically finding the best performance of the given control system. (Matlab Simulink based simulation und hands-on tuning).	Overview of control related terms, rules and principles; gaining insight into behavior of dynamic systems; design and implementation of PID controllers using iterative and rule-based methods (using Bode plots, Nyquist stability criterion)

2) Integration of guided self-study times
The guided self-study time constitutes the complementary element to the lectures. In order to support this special target group with specific temporal and personal framework conditions, exercises have been conceived that can be

permanently worked on and that provide the opportunity for self-control. The integration of guided self-study times was intended to adapt to the strong heterogenic dealing with lecture contents of the employed students, to overcome deficits, and to strengthen their individual learning process. The conception and realization of the "guided self-studies" is as followed:

- *Providing exercises*: generating exercises concretely oriented toward the contents of the given respective lectures.
- *Individually working on exercises*: in self-organization these exercises are dealt with individually. Detailed solutions are available for the student to validate their own considerations or to initialize the solving process. Content of the lectures is continually worked on, formulas and concepts are worked out and a connection to the lectures is made by "do it yourself". For advanced students, further tasks and questions with a wider spectrum are available.
- *Feedback/Reflection:* the teacher is available for questions and assists in simultaneously discovering individual problems of understanding. A quick feedback on the current level of performance is ensured as well as the possibility for reflection and just in time reaction to deficits in performance (this is true for students as well as for teachers).

In consideration of the heterogeneity of employed learners, monitored self-study time was seen as a prerequisite to provide flexible learning methods and to form and support actively the individual ways of learning for this specific students.

B. *Findings of the preliminary study*

The Evaluation in Part E of the model of educational reconstruction (see Fig. 3) aims towards two goals. On the one hand, the perceived changes by the students concerning their state of knowledge in electronic engineering are collected. On the other hand, the students' feedback about the methodological didactic design of the courses is collected. The results are a starting point for the quality control of the course design and for further cycles of improvement.

For the self-assessment of knowledge in the electrical engineering field, the students were asked for their evaluations at the beginning of the semester (measuring point T1). A post survey was done at the end of the semester (measuring point T2). The scale ranges from 1 ("no knowledge") to 10 ("solid knowledge"). Open questions about aspects of the approach were added. Fig. 4 represents the self-assessment of students' knowledge of electrical engineering for both measuring points.

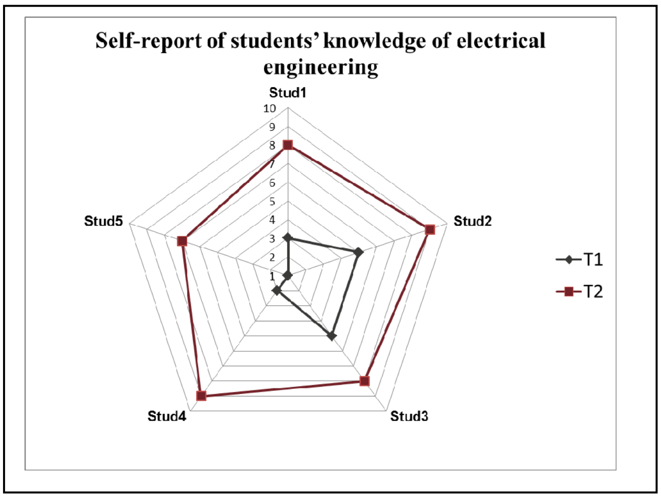

Fig. 4. Pre-Post survey of self reported knowledge of electrical engineering (students of the module "Applied Engineering Sciences", N= 5)

In the survey, every student self-reported a knowledge increase in electrical engineering. Due to the small number of participants a reliable quantitative statement was not possible. The data should rather give a reference that the students assess their own skill increase as successful. A further reference is the fact that every previous student completed the module and the exam successfully.

In respect to the methodological didactic course design, the employed students mentioned the practical laboratory part as very helpful. Reasons given in the questionnaire were mostly:

"High expectations, but practical experience through useful practical sessions in the laboratory" and

"*Very good structure, in particular the link with practical applications in the laboratory.*"

As further effects, the integration of practical experiments shows an increase in interaction between teacher and students. The small workgroups within the course set-up allowed a personal contact to each student. This led to an intense communication processes between teachers and students. A transfer of this culture of closer communication and direct feedback into the lectures became possible. Because of the strongly student-centered structures of learning and teaching the module is well equipped to deal with the heterogeneity of this specific study group.

As a result of the previously gathered experiences, the evaluation will be continued in the following years, in order to gain detailed statements about the entrance predicaments of the employed students in relation to the discipline "Electrical Engineering" and to pursue the improvement process.

VI. First conclusion And Perspectives

In summary, the model of educational reconstruction is well equipped to develop teaching and learning mechanism in professional engineering education in a theory-based manner. Furthermore, based on the collected data, the qualification of the model of educational reconstruction for the research-based development of adapted modules for employed learners is shown.

For a more in-depth and reliable analysis of the measured data a wider scope efficacy analysis in mixed-method design is planned. Additionally, this data collection will become enlarged and data for a long-term study will be at hand.

The research work shows a growth in the demand for university education closely linked to occupation and to the economy. Consequently, the universities are open through mutual knowledge transfer in the context of continuing higher education. Using the example of two professional master courses, a way of extending participation in lifelong learning, in the field of engineering, is presented.

Through the interweaving of economic problems and engineering education, a win-win situation for students and teachers is created, which improves the permeability between professional and academic education in technical professions. Not only is the transfer of new technologies into professional practice supported and expedited, but the students' input from their prior professional experience provides valuable feedback for the fundamental engineering lectures and studies.

Acknowledgment

The author would like to thank the students involved for their cooperation and feedback. Thanks to the unknown reviewers for their very useful comments in the early phase of this paper.

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