# Initiation of a course package based on the Bologna process with support of the department of educational development

A. Gharbi, T. Schwalb, K. D. Müller-Glaser
Institute for Information Processing Technology (ITIV)
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany
Adnene.Gharbi@kit.edu
Tobias.Schwalb@kit.edu
Klaus.Mueller-Glaser@kit.edu

M. Aders, A. Diez
Department of educational development
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany
Marianne.Aders@kit.edu
Anke.Diez@kit.edu

*Abstract*— **In this contribution, we present a teaching-learning-concept which enriches the education in the department of electrical engineering and information technology by the following three points: the course works with an intensive integration and matching of the elements lecture, exercise course and laboratory; new teaching and learning forms are used; and it is complemented by an intensive assistance by the department of educational development. The aim of this concept is to establish a more student centered teaching and learning in order to help the students to develop their skills and knowledge.**

***Bologna Process; course package; Information Technology; teaching techniques; educational assistance***

## I. INTRODUCTION

Based on the Bologna process, the Institute for Information Processing Technology (ITIV) decided to request for counseling by the educational development department of the Karlsruhe Institute of Technology (KIT - back then: Universität Karlsruhe (TH)) - in order to develop a new bachelor course of studies. The aim was not to just rename the intermediate diploma as bachelor degree, but to construct a course of studies with intertwining and up-building parts and arrangements.

The direct result of this counseling was the decision not to work on the meso level of the whole institute, but to choose one lecture as an exemplary arrangement on the micro level. In this context, the course 'Information Technology' - abbreviated IT - was chosen. This course consists of a lecture with the basic theories, an exercise course to work with these theories, and a project based laboratory where the students have to train their expertise. It is aimed at the bachelor students of the second semester and has no prerequisites. The working team all around IT comprises a professor holding lectures, two supervisors holding exercise sessions and supervising student tutors (20 students), who are supervising the teamwork during the laboratory and assisting the students during the preparatory learning sessions in computer pools. Detailed information about the IT course will be depicted in the following section.

## II. PACKAGE INFORMATION TECHNOLOGY

### *A. Structure of the course IT*

The IT package consists of three parts: lecture, exercise course and a project-based laboratory. All parts are strongly intertwined with each other in terms of contents and time as well [1].

The lecture counts three ECTS and thus goes over fourteen teaching sessions spread over the whole semester. The main teaching methods, which are adopted, are lecturing with the help of power point slides due to the number of the students (around 300 students) attending the course and the big lecture-hall. Nevertheless, other media like blackboard and overhead projector are occasionally used to practically show how theoretical content really works.

The lecture deals with different topics like algorithms, computer architecture and programming languages and is a kind of insight in the world of informatics for the electrical engineering students. It also gives a detailed introduction to the project of the laboratory, which helps the students to better understand the underlying theory. Due to the fact that the lecture is strongly coupled with the exercise and laboratory sessions in terms of contents and time as well, the planning of the lecture was done, unlike usual, according to some chronological and content related constraints. This came up after planning the laboratory in a first step and the exercise in a second step. This was very challenging and a tight plan was conceived. This scheduling was also adjusted during the semester. This flexibility in the course scheduling allows, unlike in traditional diploma courses, to adjust the content according to the development of the students' skills and needs over the semester.

The exercise course counts 1.5 ECTS and is held in a big lecture hall and runs over the whole semester as well. In the beginning, there is an introduction to the programming language C++. The content is coordinated with tutorials and the chapters in an additional C++ compendium, which explains the discussed C++ material with more details and further

examples. In the second part of the semester, more complex tasks are solved, which is a good preparation for the project to be implemented in the laboratory.

During the exercise, different teaching methods are used. The main medium for explanation, graphical visualization and showing practical examples are power point-slides, because of the big lecture-hall and the large number of students. Nevertheless, other methods are used according to the situation. Some questions are solved step by step with the assistance of the students using the overhead projector or the blackboard to better explain complex solutions. Programming tasks are solved in an integrated development environment via live demonstrations. This offers better insight in practical programming since the students use the same IDE later during their project. To illustrate flows in programs, especially concerning algorithms, graphical simulations are shown.

In order to reach as many individual learning styles and paces as possible, various media is used during lecture and exercise. In this way, several learner types can be reached, mainly the aural and the visual types [2]. By using active learning techniques [2],[3] like "Think-Pair-Share", a better and deeper understanding and reflection of the course material is achieved for those who prefer to learn by doing exercises themselves and by explaining to others. Such techniques keep a higher attention level of the students during the teaching session (see Figure 1) and enhance critical thinking about the contents by the students. Also, a variation of the social forms enhances the learning progress, because on the one hand there is room for those who prefer to learn alone, on the other hand there are also time slots where group learners are supported. This strategy of adopting various teaching techniques, which address different learning styles, represents an innovation in course conception and additionally enhances student centered teaching.

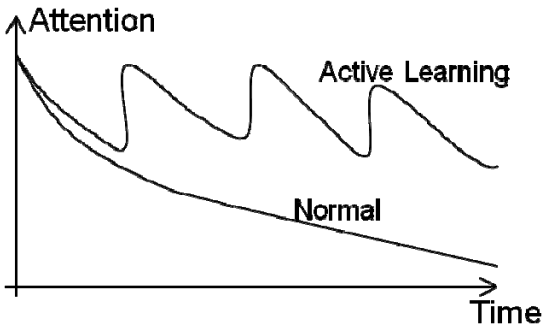


Figure 1. Influence of active learning techniques on the attention level in comparison to the classical teaching methods [4],[5],[6]

The practical laboratory counts three ECTS and includes thus seven sessions of three hours in a computer pool. In this lab, a small tool for timing analysis of synchronous logic systems is to be programmed in C++, thoroughly tested and documented in small teams of four to five students. For that purpose, the students receive handouts from the beginning of the semester which contain a detailed specification of the tool to be implemented. In addition, a project plan is suggested. During the lab sessions, three to four teams are supervised and supported by a student tutor.

The seven sessions of the laboratory take place in the second half of the semester out of two reasons. First, is needs some time until the content about the programming languages in the lecture and the concrete teaching of C++ in the exercises are finished. Second, an introductory phase in the first six weeks of the semester before the official start of the laboratory is offered. In that time, students, especially those with minimal or none previous knowledge in the world of programming, have the chance to learn the basics of C++ step by step with the help of the provided compendium and the recommended text books. Additionally student tutors offer their help in the computer pools at predefined time slots. During the offered tutorial sessions, the complexity factor rises to build up well-founded knowledge and have an easy start with the project, where the students' competences are further enhanced. Only then all students can accelerate their learning process of the programming language and have the chance to successfully complete the main project.

The following figure shows the time scheduling of the different parts of the course package over the whole semester.

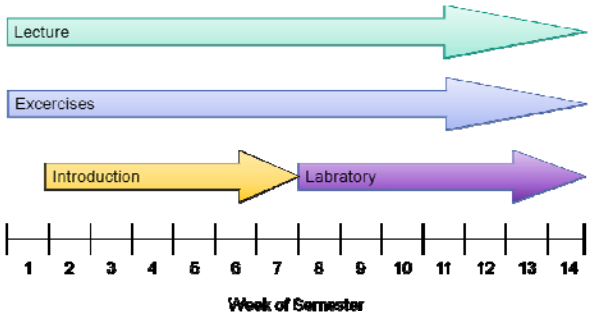


Figure 2. Time scheduling of the IT course package

The whole course material is published using a central electronic teaching platform, which is based on the open source project "Moodle" [7]. Besides the material, the platform also offers a forum which the students can use to discuss certain topics or ask questions. The latter are answered by other students, the student tutors or the supervisors. They can even be used by the supervisors while planning the next exercise sessions, since the supervisors can reproduce what the students understood and where they need more help and information. Besides, special forum areas on the central teaching platform can be used by students of the same group to discuss arising problems in the practical laboratory.

In the end of the semester, a two hours written examination is used to check the student competences, skills and knowledge concerning lecture, exercise course and laboratory. Especially skills concerning problem solving, algorithms and programming are tested. Beforehand, the project based

laboratory has to be successfully completed. For that, the students need to systematically solve a problem in groups with rules of project management (planning, tasks distribution, coordination, cooperation, documentation, etc.). At the end of the project work, the students have to present their results to their supervising student tutor and need to submit their code and documentation on the teaching platform.

### *B. Monitoring by educational development*

The aim of the arrangement of lecture, exercise courses and – especially – the project based laboratory is not only to train the student's expertise, but also to advance their soft skills regarding e.g. competences in team work and project management. To achieve this, it is necessary that the teachers and the student tutors are able to teach, to live and to reflect these skills and competences.

Therefore, a continuing process of further education and educational development accompanies the parts of the package. This is occurring on several levels: The supervisors of the exercise courses are attending courses of the educational development and aim for reaching a certificate of the state ("Baden-Württemberg-Zertifikat für Hochschuldidaktik"). The „Baden-Württemberg-Zertifikat" is awarded by the centre for educational development (HDZ) of the universities of the state of Baden-Württemberg in Germany. It attests the successful completion of a program in higher education pedagogy. The objective of the HDZ is to improve the quality of academic teaching at all universities in Baden-Württemberg.

The HDZ also conducts tailored projects designed to improve teaching conditions directly at the institutes.

To achieve the certificate, the participants have to acquire three modules: in Module I, they learn about the basics of teaching and learning in higher education with attending two workshops (two days each), a couple of cooperative counseling sessions, a cooperative in-class observation and supervision and a written pedagogical reflection and documentation.

In Module II, the participants are requested to deepen their knowledge and skills by attending workshops in four different topics relevant for teaching in a university context. The topics can be chosen out of seven subject areas such as 'teaching and learning in alternative frames', 'new forms of teaching and learning', 'planning of courses', 'accomplishing courses', 'evaluating courses', 'counseling students' and 'conception of examinations'. The HDZ provides a large range of different workshops for each topic and subject area.

To successfully achieve the third Module, the participants work on an individual project which corresponds to their individual teaching situation. During the project, they work on optimizing their teaching and improving the learning effects of the students. Thereby they are assisted and counseled by the HDZ. The project has to be reflected and documented in written form, as well as the once more the whole own learning process.

| **Module I** | **Module II** | **Module III** |
|---|---|---|
| 60 academic units[1]<br><br>The basics of teaching in higher education | 60 academic units[1]<br><br>Specialization in four of seven topics relating to higher education | 80 academic units[1]<br><br>Selection of individual topics |

Figure 3. Curriculum of the „Baden-Württemberg-Zertifikat"

The development of the IT package was based on a project with the aim of assisting ITIV in the development of a bachelor course of studies. It was chosen as an exemplary arrangement for the institute. The exercise supervisors prepared themselves for their various duties and responsibilities in the exercise course and the laboratory by attending the certificate program, choosing courses which fit the requirements of the IT package (e.g. 'Basics of teaching and learning', 'Developing practical trainings', 'Active learning with Large Groups of Students', 'Performance Training' etc.) and regular counseling by members of the HDZ. Due to the requirements of the certificate, the development process of the supervisors as well as of the IT package is therefore well reflected and documented with a didactic perspective.

To further enhance the student centered learning, tutorials are offered during the project based laboratory. For that reason, several student tutors have to be employed. These undertake as well a special program: "Educational development for student teachers - basic level". It is oriented on the above described certificate-program, but aligned to the needs of student tutors and their work. In this program, they receive basics of didactics and specific topics relevant for their work on the laboratory project, e.g. team processes, basics on project management etc. The attendance of the program is obligatory. The students have to attend four days of workshops; they additionally counsel each other on teaching concerns and interchange feedback on how they teach. At the end of the program, they have to write a reflection about this process. The accomplished training can even be accredited as a key competences course with three ECTS in the Bachelor degree.

## III. RESULTS

The feedback by the students on the new organization of the IT package has been very positive so far. In the annual evaluations, rated by the students, the main internal quality guidelines concerning structure, clearness, mentoring and the overall mark have been rated positively. Very positive elements in the laboratory are project-design, teamwork and the practical problem, which has to be solved. Concerning the exercise, the different methods and the interactive learning breaks are seen positively.

[1] One academic unit = 45 minutes

The package ran the second time in 2009. In comparison with the pilot project in 2008, a significant improvement could be seen as well. In fact, a higher motivation, enthusiasm and engagement from the students during the course could be observed. This resulted in a higher success rate in the exams.

Most student tutors of the summer semester 2009 felt well prepared for their responsibilities in the project based laboratory. They were e.g. able to structure their tutorials, and started to reflect on their behavior and the consequences out of it. Other student tutors were especially interested in the group processes and reflected this: Some found the part about group processes very interesting because theses processes are really good to observe if one pays attention to it. With the knowledge gained during the program, one has valuable indications for dealing with groups; usually one would act the wrong way by intuition. Other student tutors appreciated the possibility to share opinions, found the mutual help between the tutors a great enrichment and came to the outcome that, besides all what they have learned in the tutorials, their own private learning was also increased efficiently.

## IV. OUTLOOK

It is planned to further optimize the package and to relieve all participants from the pressure of the strong intertwining – which leads to negative consequences by rather small changes (e.g. after having to cancel a lecture session). To overcome this lack of flexibility and avoid a potential disequilibrium between the different components of the course, the practical laboratory is being shifted to the third semester, meaning one semester after the lecture and the related exercises. This way, the coupling between the lecture and the exercises offers more flexibility and the students have more time to learn the new programming language.

The development and enhancement of the course IT over the time was an exemplary process for the institute ITIV. Nevertheless, the competences and skills of the different parties all around the IT package (the professor, the supervisors, the student tutors and the students) should be further enhanced.

Based on the experiences of the planning and the realization, it is now time to move from this micro level to the meso level of the institute with its various teaching arrangements. The aim for 2010 is to use the reflected experiences and establish a revised concept for the lectures in the master course of studies.

Then it might be possible to step even further and move this way of “packing packages” to the macro level of the faculty.

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