Continuing Education at Universities: New Perspectives at German Universities

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In this paper we describe the development of a study program (for postgraduate studies) that meets most of the students' and industries' requirements by implementing a non-consecutive in-service study-program addressing different target groups and leading them all to one common master's degree. We describe the industries' needs as well as the changes that are necessary at universities to offer such a postgraduate study program targeting a broad range of students with different degrees and following the dual system education known from the German Berufsakademien. We describe what the common pitfalls are during the development of such a curriculum and how to fit the required industry-orientation into the research-oriented environment of the university. We also address issues such as high tuition fees. The last section describes our blended learning approach tackling the difficulty to give the students access to specialised hardware as well as our concept for theoretical courses.

Keywords

Distance learning, dual systems, industrial needs, life long learning, postgraduate education

1. Introduction

Recent changes in curricula, caused by the Bologna process [1], bring up the need to revise the educational structures at universities in Europe. Until 2010 all study programs have to be adapted to the bachelor/master system to fulfil the requirements of the Bologna process. In addition, in Germany the introduction of tuition fees increases the pressure on and competition between universities. With the upcoming distance learning methods, this competition reaches a higher level entering the world wide market. Therefore new ways of financing the educational system have to be found, to be able to offer a high service level for students at reasonable prices.

The equal ranking of all the different bachelor's degrees (of universities, German *Fachhochschulen (FH)* as well as *Berufsakademien (BA)* [2]) opens the master programs of the universities to a completely new audience. All students with a bachelor's degree can now continue their studies at the university to get a master's degree.

Even with the so-called equivalence of the bachelor's degrees mentioned above students coming from these different institutions still have different levels of qualification. Therefore a curriculum addressing all of these students has to consider this issue of different pre-knowledge with split course programs to fulfil the requisites of the master program. In Germany, especially in Baden-Württemberg, students have to fulfil a minimum of 300 ECTS-credit points [3] to get a master's degree. A student with a bachelor's degree of a university usually finishes his studies with 180 ECTS credit points. Other students with bachelor's

degrees might get 210 ECTS credit points during a seven semester study program[1] at a German Fachhochschule. The sums of these different achievements and the ECTS credit points received during the master program have to result in 300 ECTS credit points in total. This means that students with different attainments need different study programs. We address this issue with an extensible and split curriculum with different durations, where the different target groups take differing courses which lead them to their master's degree.

Another problem that has to be addressed within the new program is the requested "industry-oriented education". This refers to the seamless incorporation of industry-related issues into the current university curricula, which are expected to complement the institution's original research and teaching tasks. The ideal case would be to have case studies describing companies' problems; starting a lecture from an example makes it easier for students to learn the contents. However for the more theoretical courses such examples are often hard to find.

In this paper we describe one way how German universities address all those challenges with innovative curricula using distance learning methods. A blended learning approach and cooperation with the industry offer students the possibility of in-service training. Section 2 describes a way of cooperating with the industry without losing the focus on research and theoretical education.

In section 3 of this paper we describe a curriculum developed at the University of Freiburg. This curriculum is open to students with a first degree of different kinds of institutions and hence with different pre-knowledge. It is an in-service training study program (i.e. students stay in employment while studying) and leads to a Master of Science within three to seven semesters.

In section 4 we describe in detail the blended learning approach used in this curriculum and how we deal with practical courses where direct access to hardware is needed.

2. Cooperation with Berufsakademien and the industry

German universities have always had a strongly research-oriented focus. Compared to the German Berufsakademien, which have a long history of dual system education [4] and cooperations with the industry, German universities are just now starting to enter this field. The dual system of Berufsakademien is best described by a curriculum with two alternating phases: (i) a more research-oriented part, where students learn the theoretical background; and (ii) a practical part, where they work in a company (training on the job). Usually students work several months at a company followed by several weeks of training and learning. These two phases then are repeated periodically during their whole study program. The theoretical learning phase specially trains the students for the tasks they encounter in the company. Therefore the students have very specialised skills for the field they are working in.

The universities' response

Universities now try to follow this concept by introducing more industry-oriented practical courses or cooperating more closely with companies; sometimes there are traineeships. To fulfil a traineeship students have to work several weeks at a company and get a traineeship certificate afterwards. But in many German curricula such traineeships are not included and the only practical experience students have has been gained during seminars or projects. But seminars focus more on teaching experience and giving a talk about a certain topic. Projects on the other hand try to reproduce a situation in a company and the students learn

[1] Usually a student gets 30 ECTS credit points per Semester.

how to work in a team or how to solve certain problems. Additionally, students can do their master thesis in a topic that is related to an actual problem in a company.

Nowadays the industry is asking for better employability of university graduates. They complain about missing “real-life competence” and practical experience. The perfect graduate would already know how to perform the given tasks in a present-day company. University students bring a lot of theoretical background but are often missing the ability to adapt and use their knowledge in challenging situations on the job. This is why graduates from the Fachhochschulen or Berufsakademien are more popular than “overqualified” students from the university without any practical experience.

Several universities tried to remedy this lack of practical training by creating specialised study programs with a strong industrial focus. This led to a phenomenon at some universities that every few years new curricula must be developed in order to fulfil the current industrial needs (this was for example discussed in the plenum at IEE 2006 Conference).

Our approach tries to meet the industrial needs in a different way: instead of creating completely new curricula according to the temporary industrial fashions, we try to involve our students in industrial research and projects only in a few practically oriented modules. In these practical modules students get in touch with hardware problems or software problems encountered at a company. This way there is no need to change the whole curriculum, and current interesting topics can still be discussed in seminars or series of talks with experts from the industry.

All these possibilities are introduced in our curriculum for *Master Online Intelligent Embedded Microsystems* (“Master Online Intelligente Eingebettete Mikrosysteme” in German or IEMS for short) which is described in section three.

Tuition fees

Another important issue is the tuition fees. Universities offering more specialised studies are facing increasing costs of financing for their programs. This results in an increase of the tuition fees for students and consequently, a difficulty in the financing of one’s postgraduate education. Therefore in-service trainings, scholarships, sponsoring and other forms of support by companies may become necessary.

Companies can offer their employees the possibility to perform a specialised training at universities by releasing them (part-time) from their job or by financially supporting their studies.

The cost of specialised trainings like our new master program is tremendously high compared to regular tuition fees in Germany. With the introduction of tuition fees in the German academic environment the situation got a little bit easier, because since summer term 2007 students at universities have to pay a tuition fee of 500 Euros per semester. The cost of our master program (10,000 up to 20,000 Euros for the whole program, which corresponds to about 1,800 Euros per module) is admittedly a lot higher than regular tuition fees. Fortunately, by now students as well as companies are realizing that high-quality specialised trainings have their price.

In addition it should be kept in mind that the cost of our master program is easier to afford, since all the students have already worked for several years (they need at least two years of work experience to be allowed to take part) and are still working while doing their studies.

3. Developing a new distance learning curriculum for postgraduate studies at the University of Freiburg

At the Faculty of Applied Sciences (FAW) of the University of Freiburg there are two main departments: the Department of Computer Science and the Department of Microsystems

Engineering. These departments offer a wide range of topics and expert knowledge in the field of embedded microsystems. Both computer science and microsystems technologies are required to design and develop modern high-tech embedded systems. The new study program *Master Online Intelligent Embedded Microsystems* takes advantage of the expertise of both departments at the FAW. The Department of Computer Science provides the more theoretical background for efficiency, correctness, development and analyses of algorithms. The Department of Microsystems Engineering places its emphasis on hardware-related issues involving materials, chip design, connectivity etc. Combined, the curriculum offers two areas of expertise – algorithmics and technics.

Since we are addressing different kinds of students with this study program – for example students with a bachelor's degree from a university with 180 ECTS credit points (first target group), diploma students from the university with 240 ECTS credit points (second target group) or students with a bachelor's degree from FH or BA with 180 or 210 ECTS credit points (third target group) – we created three different model study programs for those three target groups. All three model study programs have a different duration (between three and seven semesters) and require the students to study a different number of modules. Table 1 shows the model study plan for the third target group with the longest study program (seven semesters).

Table 1 model study program for students in the third target group

modules	ECTS-credit points	compulsory (C) / elective course (E)	exam	semester
methods module 1	6	C	written or oral exam	1
methods module 2	6	C	written or oral exam	1
methods module 3	6	C	written or oral exam	2
methods module 4	6	C	written or oral exam	2
basic module 1	6	C	written or oral exam	3
basic module 2	6	C	written or oral exam	3
project management module	6	C	written or oral exam	3
advanced module 1	6	E	written or oral exam	4
advanced module 2	6	E	written or oral exam	4
practical module / lab course	6	C	final colloquium / written homework	4
advanced module 3	6	E	written or oral exam	5
advanced module 4	6	E	written or oral exam	5
team project	14	C	presentation and homework	6
seminar	4	C	presentation and homework	6
master thesis	30	C	master thesis and presentation	7

Nevertheless these three model study programs cannot match every kind of pre-knowledge students might have. For example, a lot of students already worked a few years in the industry and/or did special non-university training courses. These trainings and the work-experience are assessed by the admission committee of Master Online IEMS to accredit them and reduce the required workload to gain the master's degree.

To make sure all interested students can study the same advanced modules during their main studies, they should all have a comparable level of qualification when starting this part of the master program. Therefore we introduced the so-called *methods modules* and *basic modules* which have to be taken before the advanced modules depending on the first degree of the students.

The methods modules mainly address students with bachelor's degrees from Berufsakademien and Fachhochschulen that do not have so much research experience. They also can be used as introductory courses for students from not so closely related disciplines (i.e. mathematics or physics, or students without any engineering background). Here we introduce the basics of algorithms complexity, logic, statistics, probabilistic theory, simple analogue and digital electronic devices as well as concrete realisation of microsystems.

After the method modules all students have to take the basic modules to gain a common level of knowledge. These compulsory courses build the core of the curriculum and are characteristic for the following advanced courses.

In the advanced part of the program students can choose between ten advanced modules: five in each specialisation area. This way, students can concentrate on advanced knowledge in areas they did not address in their first degree. For example, a student with a bachelor's degree in a more technically oriented area like electrical engineering can choose the more theoretical computer science courses on efficient algorithms, and vice-versa. This way the study program is also opened to a wider audience. Subjects in the advanced courses are, for example, software-development methods, probabilistic robotics, signal processing, energy-efficient algorithms, analogue CMOS-circuits, measurement and sensor technology, embedded distributed systems, real-time operating systems, verification and microcomputer engineering. The current advanced courses can be supplemented by further advanced courses targeting topical subjects interesting for both research and industry.

All these more theoretical modules are supplemented by seminars, practical or laboratory courses, a team project and project management courses. In these courses students train their practical skills as well as their ability to work together on larger projects.

Another point that had to be kept in mind while designing the curriculum was that most students would prefer to make their master's degree as in-service training. This way they would be able to stay on their job and earn money while doing their studies. Hence, we decided to develop the whole study program as a non-consecutive in-service training which is taught in a distance learning scenario. Our blended learning approach is therefore described in the next section.

4. Blended learning in both theoretical and practical courses

At the FAW we are employing a special method of a blended learning scenario: The theoretical background is taught to the students using so-called *eLectures* [5] which are specially designed for in-service training (short lectures of about 15-25 minutes at most).

These eLectures are produced with the Lecturnity recording system – originally developed at the Faculty of Applied Sciences [6] – which makes it very easy to record a presentation (for example PowerPoint), the speaker's voice and his annotations on the slides. Students can watch the resulting multimedia documents (provided in different file formats such as the

proprietary Lecturnity Presentation Document, AVI or Flash) and in doing so get the same impression as if they were attending the lecture on-site.

Professors are asked to ensure that the recorded lectures do not last as long as lectures in the regular courses at a university – in Germany mostly 45 minutes. In one in-service training lecture only one topic should be discussed, thereby enabling the students to learn the lecture within one hour approximately (for example after work or during a break).

The recordings are distributed via a Learning Management System (LMS) and accompanied by weekly exercises and mentoring by specially trained tutors.

In the LMS we also offer self-assessments related to each lecture. This way, students can assess their understanding of the contents and monitor their overall progress.

Additionally to the self-assessments in the learning management system, weekly exercise sheets are sent to the students which they have to return within a specified time.

Specialised tutors attend to the students and assist them with any problems they encounter while working on their assignments. They accompany them on the LMS communicating via forums, chat or e-mail; additionally the tutors should be approachable by phone to offer further advice.

But not only theoretical courses are taught in a distance learning scenario: some of the customary practical courses in fields like sensor technology and measurement or computer architecture have been adapted especially for this program. Now there are portable construction kits consisting of the required tools for the given tasks, such as microprocessor sets, measurement devices, various hardware and software as well as the interfaces needed to connect these things with the personal computer of a student. These construction kits are lent to the students for the duration of the course and they can experiment and solve the given tasks at home in their own time.

While the online aspects of the study program are essential for our approach of the in-service training, some on-site activities remain necessary. For instance the final examinations at the end of terms, some of the laboratory courses, or the presentations in seminars are held in presence. But to reinforce the in-service training aspect of the study program, all these practical aspects are held (for example as block seminars) on weekends. This way, the studies of employees do not clash with their work.

To one point that is important to companies some people at universities must yet get accustomed to: introducing new contents or topics on the basis of case studies. Typically most lecturers at universities introduce a new concept or topic by starting with the basic theory. Then they elaborate on it and give a mathematical proof and afterwards they give a simple (sometimes specially designed) example and mention one or two possible real-life applications. Nowadays this approach is considered to be outdated by professional didacts and educationalists, as it is often rather difficult to thus motivate the new concept to the students. The new understanding is that you should start on new subjects by looking at a case study of an everyday life problem. So students immediately get an idea what the new topic is about and they realize a lot easier what the basic concepts are and why they need to know them. In our new master program, we need real-life case studies in many different subjects of computer science, microsystems engineering and so on. And as these case studies have to be relevant for the companies where our students are employed, this can be a difficulty for the academic oriented lecturers of the modules, as some do not know which examples would work best for both the students and their companies. That is the reason why lecturers of the Berufsakademien are a great help as they are used to vocational training and thus are experienced in keeping track of the currently relevant problems [7].

5. Conclusions

We have discussed our design of a study program that meets most of the students' and industries' requirements by implementing a non-consecutive in-service study-program addressing different target groups and leading them all to one common master's degree.

We have discussed how we developed the entire curriculum and how we tried to match the industries' needs with a university's curriculum by establishing cooperation with a Berufsakademie. We have argued that with the introduction of tuition fees in summer term 2007 people are more open to the idea of paying for high-quality education.

This article shows how it is possible to fit a course program for different target groups into one curriculum without creating new specialised curricula for every new topic that companies are interested in.

Despite all our efforts to integrate industries' needs into our curriculum some aspects like the creation of study cases remain difficult for some lecturers. Nevertheless the Berufsakademien will give us a helping hand in this field.

Our blended learning method is the ideal combination of easy, inexpensive production of recorded lectures and a high-quality tutoring to fulfil the in-service training needs. Since the FAW has a lot of experience in this field, we expect this method to be successful in the near future (not only for our own *Master Online IEMS* but also for other study programs).

Our approach for this kind of curriculum has gained the support of the German Ministry of Education which has approved the funding of the first three years of the study program of Master Online IEMS and two other similar programs at the University of Freiburg. Similar study programs at the University of Stuttgart are also following this way of creating in-service trainings for further education and there are more to follow.

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