Heterogeneous IT Knowledge of Students: the Didactic Approach how to meet it in the Interdisciplinary Course Program Intelligent Transport Systems

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ABSTRACT

At the University of Applied Sciences (UAS) Technikum Wien, Intelligent Transport System is a highly interdisciplinary Bachelor's degree program. Its curriculum covers several mainly technical oriented disciplines. Especially the IT courses account for the high drop-out rate of the course program. Students come with different IT knowledge depending on the one hand on their previous school education and on the other hand depending on their personal interest in IT topics. Normally, for students, IT is not the number one reason for choosing this program. Nevertheless, IT is extremely important as it interacts with all other disciplines.

Especially the heterogeneity of the IT knowledge made it necessary to rethink the way of teaching. The paper describes the new didactic approach of the IT courses in the course program Intelligent Transport Systems. The new approach faces the students' difficulties and tries to overcome the varying pre-knowledge of students. Furthermore, it tries to increase students' motivation by paying particular attention to the students' assumed interests.

Keywords: Interdisciplinary, Heterogeneous Knowledge, IT Teaching

INTRODUCTION

The University of Applied Sciences (UAS) Technikum Wien provides a set of mainly technical oriented course programs. Some programs like "Electrical Engineering" or "Computer Science" primarily focus on one specific domain. In contrary, the course program of "Intelligent Transport Systems" (ITS) is a highly interdisciplinary program. "ITS" has to deal with telecommunications, automation, information technologies (IT) etc. In more detail, the curriculum exactly covers the technical oriented fields of transportation science, automation (including sensor technology and control engineering), telecommunication engineering, mathematics, and information technology. Due to the facts, that usually some students start their studies with already gained previous knowledge in specific areas, and – naturally – students vary in their talents and main interests, in several courses heterogeneous groups can be found. Especially, in IT courses this turned out to be a crucial problem because of the wide gaps in the students' IT knowledge and skills. Lecturers face the problem of finding a suitable speed of progressing in the course. If they force the pace some students will not be able to follow. Otherwise, if they slow it down some students will get "bored". Both paths drop students' motivation and cause a shrink of the learning progress. The IT teaching concept in Intelligent Transport Systems must target the solution of this problem.

THE ITS CURRICULUM

The Bachelor's degree program Intelligent Transport Systems lasts for a period of six semesters. In total, 180 ECTS points have to be earned to pass the course program. Each semester is calculated by 30 ECTS points. An internship period in the fifth semester should prepare the students for their professional life. Thus, technical fundamentals mainly take place in the first four semesters. Several courses that thematically fit together are grouped to modules. For instance, "Module 02 – Computer Science and Telekom 1" contains the courses "Introduction to Computer Science", "Programming", "Algorithms and Data Structures 1", and "Information and Telecommunications Technology 1". Figure 3 shows a complete overview of the modules of the curriculum.

The IT Courses

Figure 3 shows that "Module 02", "Module 07", "Module 12", and "Module 17" are the modules containing the IT

courses of the ITS program. The most important IT topics in Intelligent Transport Systems are computer programming, algorithms and data structures, database systems, and data management. Starting in the first semester, consecutive courses up to the fourth semester cover these topics. A complete directory of the IT courses is listed in Table 1. All in all, the IT courses cover nearly 30 ECTS points which is a sixth part of the whole curriculum.

Table 1: The IT courses in Intelligent Transport Systems, taken from [1]

Courses	*Semester*	*ECTS*
Introduction to Computer Science	1	1,5
Programming, Algorithms and Data Structures 1	1	3,0
Information and Tele-communications Technology 1	1	4,5
Programming, Algorithms and Data Structures 2	2	4,5
Operating systems	2	1,0
Information and Tele-communications Technology 2	2	3,0
Introduction to Microcomputer Architecture	2	3,0
Programming, Algorithms and Data Structures	3	3,0
Information and Tele-communication Technology 3	3	3,0
Databases and Data Management	4	3,0
Sum		**29,5**

THE DIDACTIC APPROACH

The consecutive curriculum of the courses entails that if students fall behind at the beginning of their studies, it will be extremely difficult for them to catch up again. For instance, software programming is very complex and therefore, the one and only way to learn how to write software programs is to train it practically and continuously. In this area, it will be nearly impossible to follow up if one loses learning progress. Additionally, students called the IT courses as the worst interesting courses of the program [1]. As a result, students' IT knowledge became more and more heterogeneous. So it is not a big surprise that especially the IT topics are the top reason for the high drop-out rate of the program.

IT belongs to the fundamental knowledge in the occupational field of Intelligent Transport Systems. Therefore, it is our duty to support students in acquiring proper IT knowledge. Hence, a new teaching concept had to be developed.

The new IT teaching concept can only be successful if it is designed to take the whole IT learning process into account. This means that it has to include all semesters of Intelligent Transport Systems. Cooperation with non IT courses on the one hand and a closer focus on the traffic and transportation context in IT courses on the other hand should yield to a deeper IT acceptance of students. A specific method called the "Mentoring System" illustrates a possibility to overcome the knowledge heterogeneity of students.

The Mentoring System

One method to motivate students is to make them do things they already know and go one step beyond. Following up-to-date research from the neurobiology "enthusiasm" decides as an essential factor on good versus bad success in learning [12]. Emotions in general (either good or bad) have a large influence on the learning process. Overload and boredom are therefore two main factors that badly influence students. Thus we had two aspects in mind: firstly, we wanted to give weaker students additional help, and secondly, we tried to find a way to motivate students with extraordinary prior knowledge to help their weaker colleagues with practical lessons and exam preparation. Our experience showed that it is much easier to motivate students when they see clear benefits in the work we expect from them. In order to meet these demands we developed a "mentoring" system, i.e. a specific team work where better skilled students help and teach others.

Figure 1 shows an overview of the mentoring system. Selected students with specific prior knowledge are called "mentors" throughout this paper, weaker students with less experience and additional need for help are called "mentees", and all the other students are called "normal students". In fact, our mentoring system does not distinguish between mentees and normal students; they are treated the same way.

So what are actually the main aspects of our mentoring system? The following list explains the key factors of the system:

1. Pick out students with extraordinary prior knowledge
2. Divide the course into several topic areas and give each mentor his/her field of responsibility
3. Specify the work mentors have to do
4. Final grading

Pick out students with extraordinary prior knowledge: In the very first lesson of the course we conducted an examination (an e-test using the e-learning platform Moodle, which means that feedback and results could be given immediately after closing the test) resulting in ranking students according to their prior knowledge. The questions covered all topics of the course but the results of the examination in no way influenced the final grading of the course. The top ranked students were invited to a short interview to find out who was

actually qualified as mentor. Then, each candidate could decide by himself/herself if he/she preferred to be mentor or normal student.

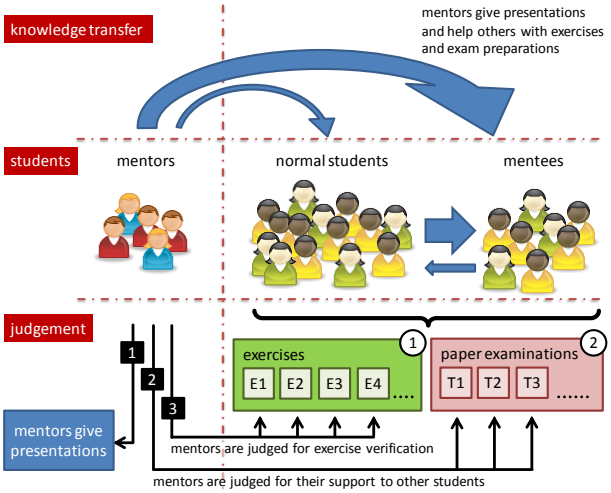
Divide the course into several topic areas and give each mentor his/her field of responsibility: This means that each mentor is not responsible for all topics of the course but just for those with extraordinary knowledge. For each single course those topics must be predefined.

Specify the work mentors have to do: In detail, this can be achieved by following several steps:

- Hold a lecture for each new topic where there exist mentors responsible for. These lectures last about 30 minutes. This guarantees that mentors are well prepared within their specific topic and on the other hand helps lecturers in conducting a course.
- Help mentees and normal students whenever support is needed (practical exercises, exam preparation).
- Verification of delivered practical exercises for completeness. The final grading process should be done by the lecturer himself/herself because students might be prejudiced in grading their colleagues. It saves a lot of time for lectures when they need not view all student exercises in detail. On the other hand, the time that is saved here must be used for communicating with the mentors.

Mentors are exempted from practical exercises and examinations. They need not visit all lessons, only those including topics where they are responsible for and where they are interested in.

Figure 1: schematic representation of the mentoring system



Final grading: While mentees and normal students are judged the same way (a mixture of home exercises and paper examinations – marked by numbers 1 and 2 within circles in Figure 1) mentors must be judged according to the work they did (marked by numbers 1, 2 and 3 within rectangles in Figure 1), i.e. in more details:

- Preparation and performance of their talk, quality of the learning material of the topic they spoke about
- Quality of support given to mentees and normal students. Judgment is done at the end of the course by all mentees and normal students in form of an anonymous survey.
- Quality and reliability of the verification of home exercises

It is important to point out that mentors must be judged for their work otherwise they won't be motivated to help others. There is high possibility that they will get a good grade at the end – mentors actually know that.

We were wondering how students would reflect on the privileges mentors have and were afraid to stir up a discord among the students. In fact it was idle fear – on the contrary, mentors were accepted as experts and students in general prefer asking colleagues for advice than asking a lecturer. Nevertheless it took some time at the beginning of the course to get the mentoring system to work properly.

Because of the increased amount of time used for organizing mentors' work and communicating with them the workload of lecturers is a bit higher than with conventional courses. On the other hand mentors support lecturers in their tasks, like giving presentations and viewing students' exercises. Thus the increased time amount is not that high.

Students liked that kind of mentoring system. Especially mentors saw a great benefit in this system because the amount of work was lower than for other students. The motivation of the mentors during the course was higher than expected and other students could benefit from the mentors' knowledge. Some points of the mentoring system have to be adjusted for the next time it is used. As for example, the gap between workload of mentors and other students was too high. Furthermore, mentees have to be instructed to communicate with the mentors right from start and the judging system for the mentors has to be improved.

Cooperation with non IT Courses

Beside the IT courses, an important part of the curriculum is given by the modules numbered by "05", "10", "14", "19", "21", and "26" (see Figure 3). The teaching method of the courses inside these modules used to be project work. These projects are in the field of ITS which means

that they normally deal with all different disciplines of ITS. Here, a core condition for projects is that Information Technologies must play an important role in the project requirements. So students are forced to deal with different kind of software programming, be it on implementing micro controllers or building control applications, etc. They feel the correlation of IT and in the transportation area. Real world projects in cooperation with companies in the area of traffic and transportation help students to understand the need of integration of many different disciplines.

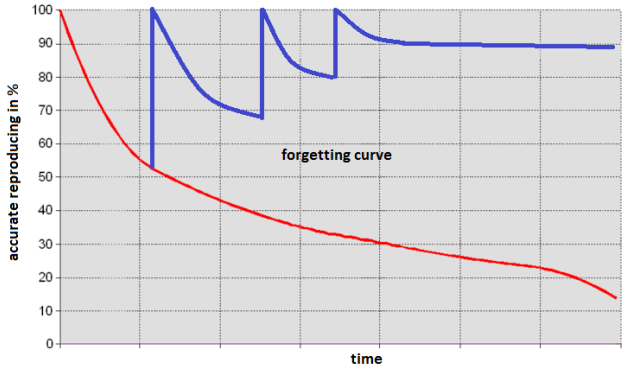
Focus on Traffic and Transport Context

Inside the IT courses themselves, lecturers are forced to find a context that fits to the students' future occupational field. So, for instance, in the database course, students work on a database that model processes at an airport with specific respect for issues in the field of air traffic. In more basic courses like the beginners course in programming these requirements need more preparation from the lecturers' side.

Specific Exam Calendar

Continuous learning is a good way for getting profound and sustainable knowledge. Figure 2 illustrates the forgetting curve and it shows that repeating (or continuous learning) reduces dramatically the percentage of forgetting. Another advantage of continuous learning is the fact that it is less probable to fall behind.

Figure 2: Forgetting curve with recapitulation cycles according to Ebbinghaus, taken from [5]



The new teaching approach aims the goal to force students learning continuously. This can be reached on the one way by increasing motivation (as mentioned above, for example, by finding the corresponding context in teaching) or on the other hand by providing specific organizational conditions.

In Intelligent Transport Systems, all exams of the IT courses are balanced in a way that requirements of following exams absolutely need the topics of previous exams. Even in the programming course, teaching is done by a three part cycle: "Lecture – practical lesson – exam" which repeats five times per semester. So students recognize very early their current level of knowledge. They see that they are on the correct way, on the other side that they need to spend more effort to catch up.

CONCLUSION AND OUTLOOK

Intelligent Transport Systems is a highly interdisciplinary course program. Especially in the IT courses students have heterogeneous knowledge. A new teaching concept including several different activities for the IT courses was implemented. The main activities are based on a "Mentoring System" and focus continuous learning of students.

The implementation of the new concept started in the summer term of 2010. Assessments are planned at the end of each semester. A complete evaluation is expected within a period of two years. Students are wanted to give feedback to each single course. So, tiny adaptations of the concept are planned after each semester as consequences of students' as well as lecturers' feedback.

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Figure 3: Intelligent Transport Systems: Curriculum Modules, taken from [1]

ECTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	ECTS
Semester 1	Module 01: Traffic 1						Module 02: Computer Science and Telekom 1								Module 03: Sensor Technology 1						Module 04: Analytical Skills 1						Module 05: Problem Oriented Learning 1				30,00
Semester 2	Module 06: Traffic 2						Module 07: Computer Science and Telekom 2								Module 08: Sensor Technology 2						Module 09: Analytical Skills 2						Module 10: Problem Oriented Learning 2				30,00
Semester 3	Module 11: Traffic 3										Module 12: Telematics							Module 13: Analytical Skills 3							Module 14: Project Oriented Learning 1					30,00
Semester 4	Module 15: Multimodal Transport						Module 16: Traffic Management						Module 17: Information Systems						Module 18: Analytical Skills 4						Module 19: Project Oriented Learning 2					30,00
Semester 5	Module 20: Traffic Planning						Module 22: Internship																		Module 21: Telematics Project 1					30,00
Semester 6	Module 23: Transport Safety; Traffic Psychologist						Module 24: Communication Networks; Logistics				Module 25: Law							Module 27: IVS Seminar						Module 26: Telematics Project 2					30,00