Reducing the drop-out rate of a technical oriented course by introducing Problem Based Learning – a first concept

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ABSTRACT

At the University of Applied Sciences (UAS) Technikum Wien one of the most difficult courses in the Bachelor degree program of Computer Science is "Database Systems and Database Design". Together with "Advanced Computer Programming", this course accounts for the high drop-out rate in the degree program. For this reason, this course was chosen for a redesign, in line with the research project QUADRO (Measures to increase quality of teaching and to reduce drop-out rates) promoted by the City of Vienna – MA 27 (EU strategy and promote economic development).

As the authors have already gained experience in Problem Based Learning (PBL), they saw an opportunity to improve students' database knowledge by changing the teaching method to Problem Based Learning (PBL).

The proposed paper first explains the current situation, identifies its drawbacks and difficulties. In a second step, it describes the new method, shows the students' feedback after the first semester and the resulting changes in the concept.

Keywords: Problem Based Learning, reducing drop-out rates

1. INTRODUCTION

At the University of Applied Sciences (UAS) Technikum Wien there are several database courses in different degree programs. The experiences of the authors show that these subjects are usually difficult for students.

Partly, these difficulties arise from the fact that the students cannot simply learn databases by heart, they have to understand the subject at a level comparable with mathematics. In addition, the underlying concepts are complex and require some commitment from the students to successfully pass the course.

The traditional approach in teaching is a combination of content lectures where theory is taught, and sessions where the students apply their theoretical knowledge.

If one looks at the grades of students and the drop-out rate one will realize this classic way of teaching does not work very well.

Since the authors were able to achieve good results with PBL in other courses, they tried to develop a concept of how to implement this technically orientated course using PBL.

2. THE FORMER COURSE STRUCTURE

The course is divided into two parts and lasts for two semesters. One part is a lecture and the other part a lab exercise. The students first attend a lecture about new content and then they practise the new content in an exercise.

For the exercise, the students are given tasks they have to solve at home. Group work was not explicitly forbidden, so the students can decide for themselves whether to solve the tasks alone or together with fellow students.

One week after the lecture, the exercise lesson takes place. Before this lesson, the students have to indicate on the course webpage which tasks they have successfully solved. This is important because to get a positive grade for the exercise part of the course, the students have to solve and check at least 50% of the exercises of one semester.

During the session, a student who has solved the task is called to present the solution. After presenting the solution, he or she has to answer questions from fellow students or from the lecturers. Then the lecturer gives feedback regarding the solution and another student is called to present the solution to the next problem.

The main idea behind this process is that the other students compare their solutions with the presented one, try to figure out if their own solution is similar. If it is, the lecturer's feedback for the presented version also holds good for their own solution. If their solution differs from the presented one, they should ask the lecturer for a feedback for their solution. Basically, they do a self check whether they have done a good job or not.

The curriculum is divided in a way that the students first learn how to query data in databases and then how to model databases. In the following semester, the students learn how to program executable code stored in databases (functions, procedures, triggers, etc.). At the end of the course students are required to work in groups on a project, and they have to apply what they have learned during the past two semesters.

Drawbacks of the former concept
In fact, this concept does not work because of these problems:

Bypassing self control
One fundamental problem is how students' performance is controlled. The idea of student self-control does not work because, instead of comparing their own solution with the presented one, most students started to prepare the next solution so as to give a good presentation in case they get called for the next problem. Thus they bypass the system and there is no benefit for the students because in the worst case they worked the whole time at their own, often completely wrong, solutions.

Missing the big picture
Bypassing the system is not the only disadvantage of the didactic concept of the old course structure. Additionally, the students do not get the big picture. They study for each task and it seems to be very hard for them to connect one element to the others and to understand its place in the entire structure. This results in low motivation to adequately deal with the issues during the course. The situation changes when the students start working on their projects. It is during their project work – at the end of two semesters – that the students realize how everything they have learned fits together.

Missing teamwork
Another disadvantage is that the course does not support those students who work in teams. This is a drawback, because it would be much easier for the students if they could help each other in the group to understand the difficult subject matter and for sure, it would be more motivating for the students if they could team up to solve the tasks together.

Lack of knowledge transfer
Traditional lectures provide much less knowledge transfer than methods that require students to research information by themselves. This has a strong impact, particularly in the profession of databases, because the knowledge must be highly abstracted to be applied practically.

This can be easily observed in the project phase where the students are only slightly able to transfer the knowledge acquired during the last two semesters.

3. PROBLEM BASED LEARNING

Problem Based Learning is a method for group learning which first got international attention in medical training. This method emerged from the realization that it can be difficult to transfer knowledge acquired in lectures to practical situations later in professional life.

The procedure of the PBL process depends upon the different authors but it is always a sequence of problem presentation, problem discussion, individual learning phases and a final discussion. Usually this process iterates several times and the problem gets increasingly complex. [1], [2], [3], [10]

4. THE NEW COURSE CONCEPT

The new concept design focuses on Problem Based Learning. Our approach does not only include a separate problem approach we try to include problems in a big picture – the database project.

The problem
Based on the concepts of PBL the students are confronted with a problem – the project. This project is much more complex than the project in the last weeks of the former course concept. Now, the students do not have only four weeks to implement the project tasks, they have a period of two semesters. The project complexity is so high that usually students are not able to solve the problem at the beginning of the first semester.

Like the project in the old course, the new one must be implemented by group work, but now the group works together for two semesters. [4]

In the current course, we instruct the students to develop the database and all necessary components (database procedures, functions etc.) for an online economy simulation. The players start their own companies in the game, buy land, start an industry, sell and buy goods, trade on the stock exchange, etc.

All these requirements are summarized in a document handed out to the students ahead of the project.

Sub-problems: Due to the aforementioned complexity and the long duration of the project, the problem must be subdivided. In our case, we have divided the problem into parts which were specified by the subject, the complexity and size in that way that they cover a particular subject of the course topic which the students can solve in two weeks.

This means that the students already get the big picture which they have not had so far, and within two semesters they will slowly develop the project by solving new sub-problems in bi-weekly steps, and thus they expand their knowledge by this.

The Four Phases
The PBL process is divided into four phases. In the course, one iteration of each phase takes two weeks, during which each of the four phases has to be passed and then the new iteration starts. Each iteration is based on the previous one, and thus the knowledge of the students expands on every iteration (see Fig. 1)

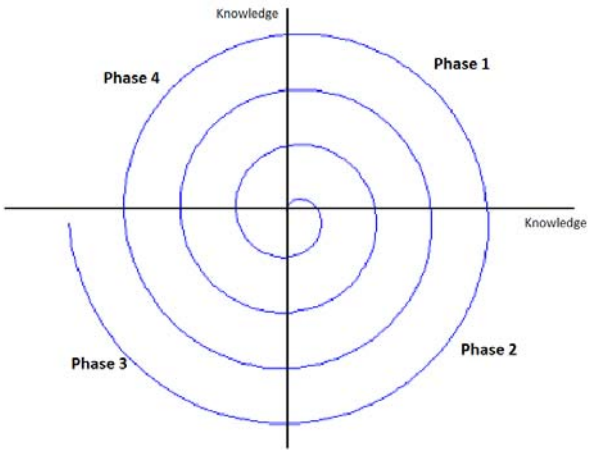

Fig. 1: Spiral model of the 4-phase iteration

Phase 1
In each Phase 1 the students get the new sub-problem with its tasks. How they handle this first phase is up to the students, but generally they have to analyze the problem and discuss in group which parts they can already solve because of their knowledge from prior sub-problems and for which part they have to do research. [5]

Phase 2
Phase 2 is the information research and group solution phase. First the students gather the information they need to solve the tasks of the sub-problem and then they provide their own solution. It's absolutely necessary that the group works together because no individual solution is acceptable, only the solution of the whole group counts. (see **Phase 3**)

Phase 3
Unlike Phase 1 and Phase 2, which are completed by the students under their own responsibility, phase 3 takes place during the practice session in class. In this phase 7 to 8 groups are in a class which lasts 90 minutes. In the course there are two lecturers so each lecturer has about 20 minutes for one student group. Those 20 minutes are called "coaching session".

During the coaching session the lecturer acts as the project leader. In this session, the lecturer calls for a status report from the students and demands the group solution for each task of the sub-problem. For each task solved, the group gets the corresponding points. If the lecturer asks a student to present the group solution of a task and he or she is not able to show it, the group scores zero points for this task. It does not matter if another group member could show the task solution; it is all or nothing. (see **The Embedded Mentor**)

In this coaching session the lecturer also gives feedback on the quality of each solution and gives assistance for the task the group could not solve. The authors think these two objectives are very important for the learning progress of the group. [6]

Phase 4
Phase 4 is the lecture phase, a repetition of the knowledge they have researched in Phase 2. In this phase, the students consolidate their level of knowledge so they can start the next iteration.

The Embedded Mentor System
As stated Phase 3, only the group solution counts and no individual solutions. The basic idea behind this rule is that we do not want good students to produce their solutions for the group and weaker just run along. Rather, the good students should help the weaker to understand the topic. In other words, the better students should be mentors for the weaker ones. The main problem was the question how can we get the good students to spend their time with the weaker to teach them. The simplest solution was to force them because their grade was indirect influenced by the success of the weak students.

Grading
Each semester is graded based on two exams the students have to take, one in the middle and one at the end. On each test, the maximum score is 20 points. The points of both tests are added, and serve as the base value for the grade. To achieve a pass grade in the exercise part, the group has to solve at least 50 percent of the exercises. Both parts, on the one hand the points for the two tests together and on the other hand the exercises have to be positive. [7], [8]

In addition, students can earn points through the exercises. A group solved more than 70% of the examples each group member gets one point added to his test points. These points are increased in 10 percent increments up to a maximum of four extra points for 100 percent dissolved examples. This means that students can earn up to 10 percent of the maximum test score through the exercises and the success of their group.

This grading supports the mentor system, because now the better students depend a little bit on the learning success of the weaker ones. This makes better students help weaker ones. [9]

5. FIRST SEMESTER FEEDBACK

After the first semester we surveyed the students on what they think about databases and what they like about the new method and what they dislike.

In **Fig. 2** one can see, that 68.87 percent of students think database is difficult or very difficult. We obtained comparable values with the old method.

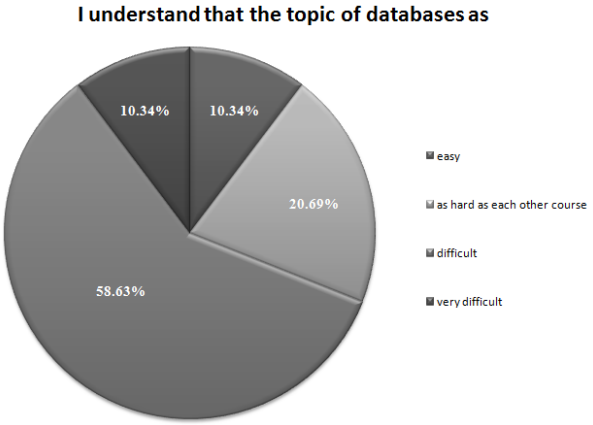

Fig. 2 Difficulty of the database topic

When asked what the students think about the coaching session, 72.41 percent responded that it was an interesting alternative:

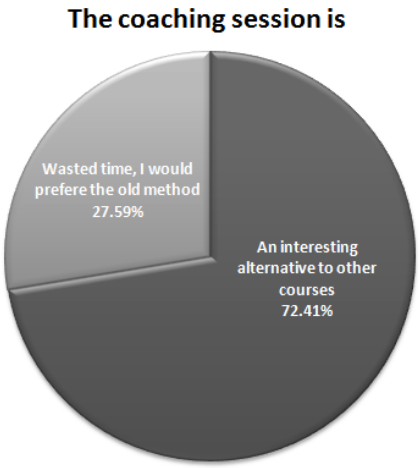

Fig. 3 The Coaching Session

However, this statement is revised by the next question as can be seen in **Fig. 4**. 58.62 percent say that their impression of the course is slightly negative or even absolutely negative.

From these two issues could be inferred that the students generally are not averse to new teaching methods, but there is something with the new method they don't like. What it is it can be seen in the statements of the students (see **Difficulties and Problems**)

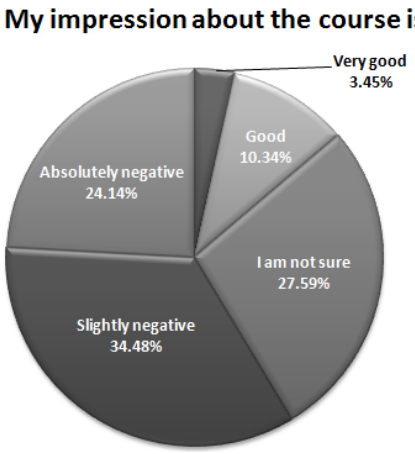

Fig. 4 Impression about the course

On the question of research, 65.52 percent of students said that research is labor intensive (see Fig. 5). The authors agree with this statement completely; in our opinion, however, this time-consuming research has a positive effect on the duration of knowledge and thus has a direct impact on the quality of the students, and later graduates respectively. Apparently, at least 20.69 percent of students share this opinion because they said that through research, they learn more than in a normal lecture. This compares to 13.79 percent of students who think that they learn nothing at all through research.

Unfortunately, 58.62 percent of students would prefer a lecture. This comes as no surprise, a most students have experienced only this teaching method because it is apparently still the preferred method of teaching in Austria.

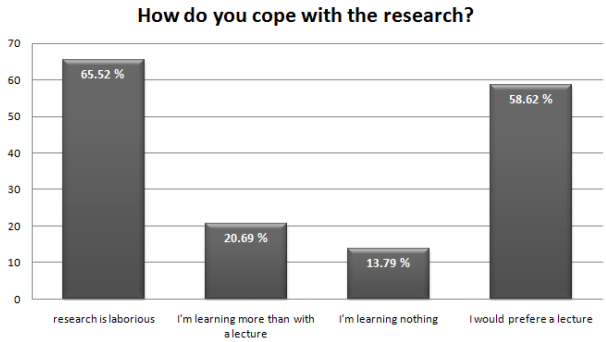

Fig. 5 Questions about the research

Difficulties and Problems

The following problems could be derived from students' feedback.

Too time consuming

One main complaint of the students is that the new method is much more time consuming than the old system. Of course, the students realize this fact and this makes them adverse to the new method.

Apparently, the students were disoriented during their research because some tasks were defined too vaguely. Since the students did not exactly know what they had to research, the search was too time-consuming, as they spent too much time with unnecessary research.

Certainly, the new method is more demanding not only for the students, but also for the lecturers. The coaching session is much more strenuous for the lecturers than the old practice session, because now we do not only have to evaluate each example once but once per group. In addition, with the old method, the tasks were based on one database model. Now, each group has its own model. Thereby, the lecturers have to understand each new solution of each group first to give a feedback to the group. This is very stressful.

Although the research sometimes took far too much time, the students naturally see only their own time and not the time spent by the lecturers. Some students' feedback indicated that they think they have all the work on their own, and the lecturer now has much less to do than with the old system. This shows that we failed to transfer the idea behind our new method to all students, which in turn resulted in lower motivation for the new method.

Group Grading and inhomogeneous group setting

From the beginning, the students were against the group-based assessment of the exercises, and so we got much feedback about it.

A few students wrote that some other students did not use the mentor system as an advanced learning support for their personal use but for the exact opposite. Those students did only the minimum necessary and counted on the fact that the mentors will solve the examples and provide them with the solution to get enough points.

During the semester we saw that in the beginning the new concept worked as expected, and each student was always prepared. In the last third of the semester, however, not all students in the group were always prepared, and therefore, some students lost points. A subsequent analysis showed we had not considered the fact that some students in the group simply try to prepare the minimum while others want to have the extra points. The group rating in this case led to a situation in which students sometimes got no points on examples they had prepared, because in the coaching session a group member who was ill prepared had to show his/her solution.

6. CHANGES FOR THE SECOND SEMESTER

More precise problem specification

We decided to solve the problem that research was perceived by students as too time consuming by changing two things. On the one hand, we explicitly point out the affected area to each new

task, and on the other, the students get a “sneak preview” at the end of Phase 4 (the lecture) – one slide per topic of the next iteration. Direct talks with the students showed us that these changes are very well accepted and perceived as a positive modification.

Change of Mentor System and group grading

Group grading has turned out to be a failure, and had to be skipped. This means that a completely new mentor system has been developed. Now, one student per group can register as a mentor whose mission is to support the other group members. At the end of the semester, there will be a survey for each group showing how well the mentor has fulfilled his/her task. If he has done a good job, he gets credited exercise points which make reaching extra points for the test easier.

We have learned from the students that the change of grading has been very well accepted, but the mentor system has not been received so well, as students think that it makes no sense.

7. CONCLUSION

The authors are convinced that due to PBL, the learning outcome will improve and become more sustainable. As a consequence, the drop-out rate of students in database course will hopefully be lower.

This will happen due to the many positive changes in the course, such as:

- From the beginning the students can detect correlations of the learned knowledge better.
- The students move from a predominantly passive to a more active role. This furthers the students' progress.
- The support for the student is intensified with a constant time budget.
- Because of the successive sub-problems knowledge gaps can be quickly identified and closed.

Whether the new method helps us achieve our goal to decrease the drop-out rate will be seen in a few years. However, the most ambitious method has little sense if it is not accepted by the students, because in this case their motivation decreases and thus also their progress.

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