Database System within the Computer Science Education

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Abstract: - This paper describes methods and tools used for the Database Systems (DBS) instruction at the University of Hradec Králové. In the DBS courses, the theoretical issues are followed by practical training. Thus the learners have possibility to study both the theory and work with practical database products—ORACLE, MS SQL, DB2 a MySQL. The students work on several practical projects within the DBS courses. They co-operate in teams on developing an operating database application for a real (or virtual) organization, e.g. small businesses or services organizations. Students should go through all stages of database development - the analysis, conceptual, logical and physical design. The process of instruction is supported by eLearning courses in the LMS Blackboard. In this paper tutors’ and students’ experience from these courses is presented and discussed.

Key-Words: - Computer Science Education, Databases, Multimedia, Internet, Educational Software, Web-Based Education

1 Introduction

Currently, the subject of Database Systems (DBS) has become an integral part of almost all computer applications. That is why students are expected to be well-prepared in this field.

The Database Systems courses have been included in the undergraduate master study programmes of Information Management and bachelor study programme Applied Informatics at the Faculty of Informatics and Management, University of Hradec Králové. The undergraduate curriculum was developed on the ACM model curriculum (ACM, Association for Computing Machinery - the world's largest educational and scientific computing society, delivers resources that advance computing as a science and a profession). Now two DBS courses are provided on the bachelor level and one (elective) course on the master level. The DBS1 course introduces the concepts and techniques of database systems:

- Database Management System (DBMS) functions and data independence,
- Conceptual database design; E/R model,
- Relational model,
- Mapping conceptual schema to a relational schema; entity and referential integrity,
- Relational database design, normal forms,
- Relational algebra,
- SQL.

This course directly follows-up on Object Oriented Modeling and Programming and it is compulsory for students of both study programmes (Information Management and Applied Informatics).

The DBS2 course focuses on advanced database topics as follows:

- Data models,
- Architecture of a DBMS,
- Client/Server systems, advantages and disadvantages of C/S, platforms C/S, front-end products,
- Distributed databases and data protection,
- Concurrent operations on the database,
- Replication, ODBC,
- Benchmarks,
- Internet and DBMS.

This subject is also compulsory for students of both fields.

The third course - elective for the students of master study programme - is called Modern Information Systems (MOIS). It focuses on emerging trends and technologies in the field of information systems development.

All three courses are divided in 2 hours of lectures per week, two hours of tutorials per week and 1 hour of students’ independent work.

Lectures are devoted to summarizing the theory and practical examples, other examples are provided within tutorials.

The students work on two projects in the DBS1 course. The first projects deals with the data modeling and creating databases, the second one focuses on work with data – SQL queries, triggers and views. Students can decide whether they prefer practicing in ORACLE or MS SQL Server.

The DBS2 course gives students possibility to operate in groups. Students’ teams are formed in order to develop an operating database application for a real (or virtual) organization as small businesses. Students should go through all stages of the database development - the analysis, conceptual, logical and physical design. Students can choose one or more of four 4-hour elective workshops aiming at deepening their knowledge in technology

- MS SQL and .NET,
- ORACLE and APEX,
- MySQL and PHP,
- DB2 and JAVA.

The MOIS course provides students with possibility to participate in the development of real-life application.

3 Practical Approach

In our courses the strong emphasis is paid to practical training. It is organized in following way.

As mentioned above, students prepare two simple projects in the DBS1 course. The first project concentrates mainly on conceptual design and its transformation to relational tables. In the second project students create simple database according to given precise specification and thus create tools for manipulating with data – 5 specific SQL queries, three triggers and views.

In the DBS2 course students develop an operating database application for a real (or virtual) organization as small business or service organization.

3.1 The Students’ Projects

Projects offer a number of benefits to students of DBS courses.

It is the best way to expose student to applications of the database design cycle and its use in practice. These include interaction with users, extracting requirements from users who do not have a clear conception what they require, and prototyping.

Students must go through all stages of database development - analysis, conceptual, logical and physical design. The project also teaches students the benefits of prototyping and user feedback. And, it trains students to work in groups, too.

3.2 The Students’ Teams

The project in DBS2 is organized to be conducted by teams of students.

The size of each group is from three to four members. Fewer than three members is not useful, it would be much work for each member, and the group of more than five members is difficult to coordinate.

Each students’ team should have members with complementary skills such as communication and leadership.

3.3 The Scope of the Project

The aim of the project is the database application on real (or virtual) organization. Students can be asked to search for their own project or it can be assigned by the teacher (instructor).

The scope of the project should be decided after the consultation with the instructor. The project must contain five to ten entity types and has to cover all stages of database design.

Each team provides a brief presentation of the project to the classmates and delivers a written report detailing the analysis, design and implementation of the prototype. This report must include User’s Manual and Programmer’s Manual.

The User’s Manual contains information about setting up and installation of the application and instructions how to use the application.

Parts of the Programmer’s Manual are specified for the students. The Programmer’s Manual consists of two sections

- Programme documentation (Installation, Programme hierarchy, etc.).
- Programme design (Placing of project, Detailed Analysis, Data Model, Physical database structures, etc.).

### 4 eLearning and Database Systems

Currently it has become of common level the university course was supported by the web-based education. [3]

E-learning courses are understood as standard in higher education and provide numerous advantages to the learners, tutors and institutions.

From the learner’s point of view the accessibility of study materials anytime anywhere is the most appreciated feature, follow by financial savings in commuting expenses [1]. Teachers emphasize efficient and immediate feedback and the institutions can also reach some financial savings form eLearning. [6]

The process of instruction can be supported by various educational software; virtual learning environments based on LMS are often used [2].

New learning materials supporting the electronic way of instruction, which are called e-subjects, were created in the Learning Management System Blackboard for the students of the Faculty of Informatics and Management. Various study materials for the DBS2 course are presented in figure 1.

![Fig 1. Example of study materials in subject Database Systems 2](image)

The materials in the e-subject contain study texts. Lectures were available in the HTML form with animations and hypertext links, so that students could easily understand the topics. MS PowerPoint presentations, which support face-to-face lessons, were also included in the study materials and single topics were supported by video-recorded lectures.

Figures 1 and 2 are authentic extracts from electronic study materials.

![Fig 2. Example of presentation](image)

Each topic was linked to a selftest so that students could check their subject knowledge and immediately know whether they understand the problem correctly, or not.

Figure 3 provides an example of a multiple choice question. One of significant advantages of testing in LMS was the option to flexibly change the setting of testing as presented in figure 3.

![Fig 3. Example of selftest](image)

Students also use two asynchronous communication tools in LMS – discussions and e-mail.

### 5 The Efficiency of Instruction in the Subjects of Database Systems

The process of instruction which is run in the above way described way has become the objective of research activities. The research subject was stated as students’ performance in the LMS-supported instruction in the cognitive area (experimental group) and its comparison to the students’ performance achieved in the traditional way of face-to-face instruction (control group). The basic research question was to learn "to what extent the increase in knowledge and skills, students’ interest
and motivation were influenced by eLearning (i.e., LMS) supported process of instruction in the subject of Database Systems 2.”

The method of pedagogical experiment comparing two groups was applied. It was a quantitative research in which mainly didactic tests and questionnaires were applied as research tools. Statistical methods express significant differences in the collected data.

In this research the convenience sample was applied. It consisted of students of the Faculty of Informatics and Management who enrolled in the subject of Database systems 2 in 2010/11 academic year. The experimental and control groups were formed by random selection. One week before the term started, students enrolled in one of nine seminar groups according to their scheduled requirements. Then, it was randomly decided which seminar groups will be included in the experimental group and which ones will belong to the control group. In all phases of the research 66 students were included in the experimental group and 61 students in the control group.

Didactic tests implemented in the research aimed at measuring results in the process of cognitive learning. In the didactic tests the reliability, difficulty and sensitivity (Upper-Lower Index (ULI), Tetrachoric Correlation, Point Biserial Correlation) of particular tasks placed into the test were monitored.

Seven tasks were set up for the pretest. The posttest contained 17 tasks and the second posttest, running six weeks after the first posttest, contained 21 tasks. [4], [5]

Data processing arose from the database containing all students’ detailed results. Data were processed by NCSS2007 statistic software. Using both the T-test and non-parametric Mann-Whitney test the variance analysis on the 0.05 significance level was done so that the equality of samples in the pretest was checked. No statistically significant difference was discovered between the pretest results in experimental and control group performances, so the groups were considered equal (Figure 4). This entitled us to run the pedagogical experiment.

The null hypothesis “There is no statistically significant difference in the posttest performance provided by students in the experimental and control groups” was verified by T-test on the 0.05 significance level, so the findings have probability of 95 %.

Finally, it can be stated that the hypothesis “Students in the experimental group reach comparative performance in cognitive learning after the instruction to the students in the control group”, was accepted.
6 Students’ Attitudes
A survey and interview were used to get information on students’ attitudes towards the content and form of instruction, and to what extend the process was time consuming for them.

Questions stated in the questionnaire were created on the basis of analysis of previous interviews with students. The questionnaire comprised close and semi-close questions, open questions were rare. The form of close answers was chosen intentionally. There were two reasons to do so: easier evaluation of answers, and higher willingness of respondents to truly fill in the questionnaire.

Students expressed their opinion whether the subject met their expectations. The item “Did the content of the subject DBS meet your expectations?” was evaluated on the 5-level scale: I am fully satisfied - I am satisfied - I have no objections - I expected something else - I am not satisfied. Single responses were evaluated from 1 (full satisfaction) to 5 (total dissatisfaction). The average response was 2.5, i.e. between I am satisfied - I do not have any objections. In the control group the average value was 2.52, while in the experimental group it was 2.55 (Figure 7).

Students also evaluated the extent and content of the subject, i.e. how much they learned, on the 5-level scale: the content was (1) too large - (2) large - (3) adequate - (4) insufficient - (5) totally insufficient. Students of the experimental group reached 2.89, students in the control group 2.84, i.e. in both groups the content (extent) of the course is considered adequate. (Figure 8)

Students in both groups specified how many hours they spent working on the project and preparing for the final examination.

Students of the control group spent on average 38 hours working on the project and 14 hours preparing for the exam. Totally they studied 52 hours. Students of the experimental group spent 50 hours working on the project and 15 hours preparing for the exam. Totally they studied 65 hours. (Figure 9)

So, it can be stated that students expectations in the control group were met a lesser extent (but the difference is not significant).
Fig. 9  Time spent on studying

Single data show that students devoted more time working on subject (12-230 hours in the experimental group and 8-230 hours in the control group). Students in the experimental group spent 2-80 hours preparing for the examination, students in the control group spent 1-80 hours.

It is interesting, as the results prove that both groups reached the similar level of meeting expectations and satisfaction with the course content and extent but students in the experimental group think they worked on the project ¼ hours fewer and prepared longer for the examination in comparison to the control group.

7 Conclusion

Databases as an integral part od current computer applications are of great importance, and they are included in curricula of the Computer Science Education.

Both the theoretical knowledge and practical skills of students are highly required. In the time of information society eLearning courses supporting the process of instruction are often used.

In case of well designed and appropriately implemented eLearning course the results of students who attended e-learning subject are comparable to results achieved by students of traditional face-to-face lessons. No substantial differences were discovered in students’ attitudes.

References: