Web-based SQL-Teaching

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Abstract

SQL is the still the number one database language that is used in enterprises as well as in university teaching. As a kind of programming language, SQL cannot only be taught with paper and pencil but it is evident to use computers. Students have to make experiences with a real data base in order to understand how they work. When teaching SQL the main problem is that students may "get lost" in the data base: They can destroy the underlying data base scheme or delete too many data sets. Then, case studies or exercises that build upon each other cannot be solved correctly or students cannot verify if they solved the exercises correctly because they work on a modified data base that is different to the one that is assumed when creating the exercises and computing the reference output of SQL queries. Besides, if students work on the same data base one student can influence or destroy the work that was done by another student. Thus, the learning progress of a student can be negatively affected not only by himself or herself but by other students.

In order to solve this situation, an e-learning system for teaching SQL was realised. This SQL system provides a data base environment to each single student that is separated from other students and cannot be influenced by others. There, students can build their own "private" data base with which they can work during the courses. In order to be able to provide case studies and consecutive exercises predefined databases and schemes are provided so that students can always return to a standardised data base state.

As the e-learning system is web based, the usage is not restricted to courses. It can also be used by students whereever and whenever they have access to the internet and want to practice. It is accompanied by exercises that explain the usage and functionality of a data base step by step. During this learning process, there are different milestones that are provided by the system so that it is not necessary to always start from the beginning. If students are already experienced in SQL they can start at a predefined milestone and continue their learning process.

The SQL system is used since several years during lectures in bachelor and master courses. We analysed the usefulness of the system concerning the learning progress of students. In both courses (bachelor and master), the use of the system has clearly led to a better understanding of SQL.

1. Motivation

E-learning is commonly used for all kinds of learning where digital media are used.0 That means that as long as instructors or learners are using digital media in order to present, to distribute or to consume learning material as well as to organize courses/lectures or to communicate learning related we are talking about e-learning.0 In general e-learning is mainly used for five tasks: (1) Administration, (2) Provision/Consumption of material, (3) Practicing, (4) Cooperation and communication and (5) Assessment and Grading. The administration task concerns the organisation of lectures, i.e. building courses, mailing lists etc. The provision and consumption of material started about 20 years ago with the development of computer based trainings on CD-ROM, which allowed for the first time more complex forms of e-learning and practicing. It is closely connected with the practicing task. Since then, as in other areas of communication teaching has been heavily influenced by new information and communication technologies in recent years and decades. Since then e-learning research has always dealt with two aspects:

-Using new technologies in order to provide material that is up-to-date in a technical manner.
-Creating e-learning environments that are interesting to learners and really help them to learn and understand the lessons.

The first aspect influences the way of learning: At home or everywhere, static or mobile. There occur certain constraints or possibilities depending on the technology used for e-learning. But mostly, the

concepts remain the same: Knowledge is presented via video or hypertext. Exercises consist of multiple choice, fill-in-the-blank, jumbled-sentences or wrong-false forms. But then, learners don't really need their knowledge because often they easily can guess the correct answers by systematically reducing the number of possible answers.0

Therefore, the second aspect deals with the concepts of providing information to learners: How could content be brought to learners in an interesting and didactically good way so that students or pupils do not get bored and really learn new and relevant things? Since many years, so-called intelligent tutoring tools are in the focus of research.00000 These tools are developed for the purpose of providing sophisticated e-learning exercises that do not contain the solution of an exercise in a more or less apparent form. This is known to be the prerequisite for effective learning and good understanding, because learners have to find the correct solution independently, as they have to apply their acquired knowledge on their own instead of solving through the trial-error principles.0 Although the use of such interactive and challenging exercises is often requested, 0 they exist only sporadically in the area of e-learning because of their complexity.0

2. Requirements for E-Learning-Systems

An appropriate e-learning system should consider both aspects equally. To enable self-directed learning, which is generally regarded as the most efficient learning, 0 a system should be technically up to date and use current trends. They offer numerous opportunities for e-learning tasks and tools and their interactive and multimedia nature are essential for e-learning. As a side effect, students are able to learn anytime, anywhere without restrictions via Internet.

Additionally, e-learning systems should give - if possible - direct feedback to the user, what solutions of a task was solved well or poorly. 0000 Otherwise the learning process slows unnecessarily and comes to a halt when the lag between processing of the task and feedback on the approach takes too long. In this case, learners might not remember exactly the problem and its solution, so that a smaller learning effect occurs. Besides the technical requirements, e-learning tasks should be more demanding and complex than the simple forms above.00 Otherwise, a learning process is normally difficult to be observed and measured.

One of the main reasons for the use of e-learning is the request for individual attention and guidance of the learner, based on their knowledge and skills. To ensure this in combination with time- and location- independently form of learning, it is necessary to provide support at any time. This should include a detailed feedback on errors, whereby not only the errors are determined, but also hints for correction are given. For individual support of the students the e-learning platform should provide milestones where students can always go into the subject. Otherwise slower students could hardly catch up to their fellow students in case of loss of connections. The knowledge gap doesn't necessarily increase through the use of milestone with the progress of the course, but is limited to individual segments between milestones.

3. E-Learning-Environment WiSQL
3.1 Overview

Modern information systems are usually based on an SQL database. As with learning any other programming language practising with SQL is essential. Therefore, 2003 the chair of Business Informatics of the Technical University of Dortmund developed an e-learning system based on the above-named requirements that allows students to learn independently and interactive SQL. The system is called WiSQL and it provides via Internet portal its own, separate database for all students available. There the students can work through a specially developed surface, without any interference with each other at work. This enables students to improve and consolidate their knowledge, without any installation and set up of an own database server, in relation to the implementation of Entity Relationship Models (ERM) in a SQL database, and the subsequent use and retrieval of data.

3.2 Concept of Application

WiSQL is used in two ways: First, it offers students the easy opportunity to practice outside of lecture times SQL by working on a database. Second, the system is used as part of tutorials. Mass events make individual support difficult. For this purpose, there are tutorials in small groups up to 25 students, in which students are introduced step by step through SQL. Each tutorial consists of several small tasks which are solved together first and over the time more independently of the students. It is essen-

tial that the students practice the tasks directly on a database with help of WiSQL. Sample solutions to the various tasks are not made available, however, the expected expenditure of the system to the various tasks are supplied. So the success control is possible any time. Since the tasks in the tutorials are based on one another, it is necessary that the above-mentioned milestones are provided by WiSQL, so that in the course of the tutorials it can be placed over uniform.

3.3 Structure

The portal is divided into the main areas Web Console, Documentation and Service. The Web Console provides the main functionality, working with a database using SQL (see Figure 1). The central item on this page is the SQL text area. This makes different functionality available for the interaction with the database. Core element is the SQL Input field. Here you can enter SQL commands which are sent to the underlying database management and which are validated. If the command contains syntax errors, the students will be informed.
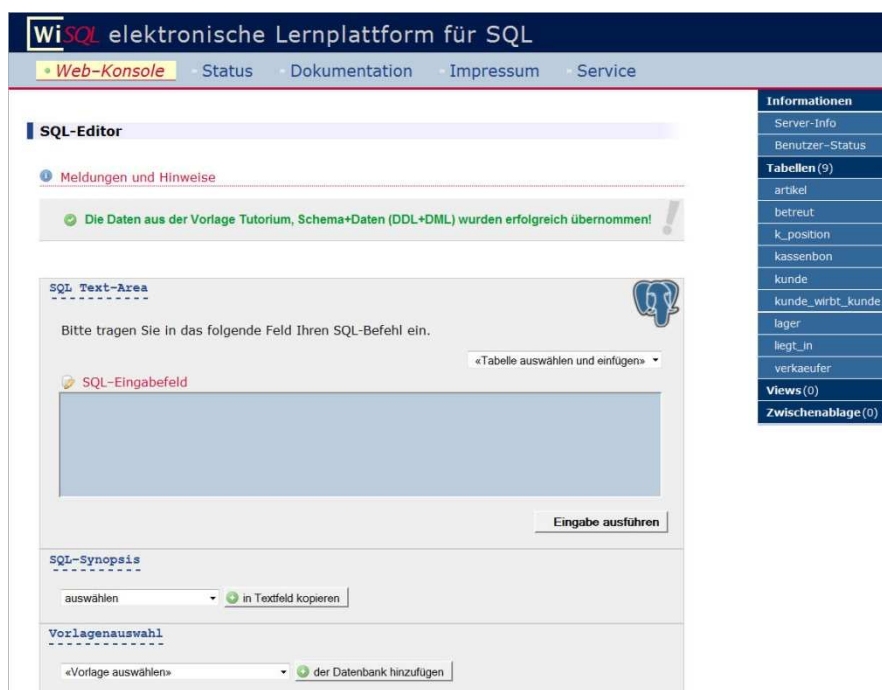

Figure 1 : Web-Console

The corresponding error description is also given, so that the SQL command can be checked and corrected. Therefore, the previously entered command is received after sending the command. In support of the input, a list of existing tables can be found above the input field. Selecting an existing table inserts the corresponding table name in the SQL Command field.

As additional support WiSQL offers below the input field, a list of common SQL commands. This adds after choosing the syntax of the selected command in the SQL text box. Especially at the beginning this help supports the learning process, since learners don´t have to interrupt the process for finding solutions to look up the syntax. The intellectual right then includes filtering of the relevant parts of the SQL command and the correct allocation of the necessary input data to solve the specified problem. In the course of the learning process this function should be increasingly replaced by the own knowledge of the students, but offers in doubt, still a quick reference. At the lower end of the SQL text area, the various milestones of the tutorials can be selected at the „assortment of templates". This allows slower students who may have lost the connection, to draw level with the other students by calling a milestone. The milestones are pre-defined database schemas and data pools, which include intermediate goods, which the students reach in the ideal case itself through the solution of their exercises.

However, since errors in the design or implementation of the database schema and at the input or change of data in the database cannot be excluded, it is ensured by the use of the templates that the databases of students are up-to-date and correct, so that the learning improvement isn´t disabled by

past errors. On the right side is the information part of the Web console. This includes the exact image of the current database schema, i.e. a representation of the created database tables, including data types and metadata such as the name of the parent column for foreign keys, or information about conditions not null. Clicking on each table generates a simple SELECT command so that the contents of a table can be viewed quickly at any time. At the lower end of the information part the so-called „Clipboard", which has a history of the last ten entered SQL commands and can thus present the course of finding solutions by clicking. The second main area of WiSQL the documentation includes instructions for using WiSQL, a quick reference and further reading. The methods of use explain the functioning of the portal and the restrictions that were made for safety reasons. The quick reference presents the most important SQL commands at a glance, explains their workings and the effect of individual parameters. The third main area service provides functions so that user databases can be backed up, restored, removed and analyzed. With the help of database backups, an intermediate state of its own database can be created and loaded again by using the restore function. Thus, this function gives the students the opportunity to produce an own model as you can find it in the web-console. The SQL dump (structure, data or both) offers advanced students the opportunity to export their work and to import it into a separate database server. The creation of a database schema allows students to generate the underlying database schema from their created database. Here, the native implementation can be compared not only with the desired schema, but here is also shown the immediate context of the process of database modelling and it is built a bridge between different parts of the curriculum. Furthermore in this area, all data in a database and/or the database structure can be deleted totally.

4. Results

WiSQL is used in the lectures information management (IM) and Data Modelling and Database (DB). Before using it in IM, there was worked on the basis of MS Access, in DB no system was used. In the winter semester 2003/2004, the system was first tested in IM. As shown in Figure 2, this year is no improvement achieved in the average score in the examination of the SQL task, but in fact worse. This was because the system was used without proper documentation in this year when it was completed, and so the educational aspect was not adequately adjusted. After the adjustment of the documents and the preparation and adaptation of the didactic concept in the following winter semester 2004/2005 was a significant improvement in the average score noticeable (about 55% to 44-48% previously), which has since been a slight upward trend holds on the level.
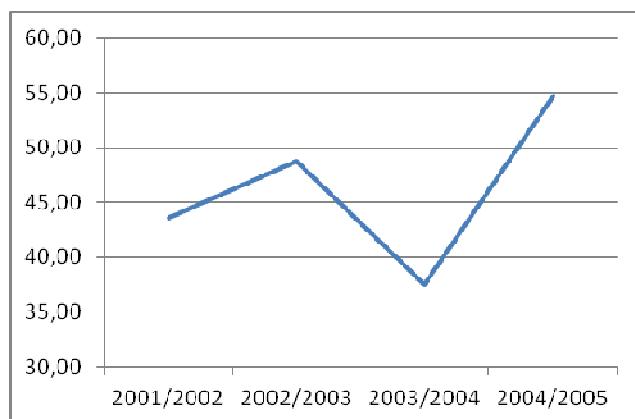

Figure 2: Development of information management exam points

In DB, the system has been used since the summer semester 2007. Based on the experiences in IM the concept was developed for this event prior to the application, so that in the first year was already observed a slight increase in the average score (see Figure 3). Surprisingly, however, the score breaks the following year strongly. This effect is due to two reasons. First, the considered task in the examination consisted this year not only from SQL functions, so that no perfect comparability exists among the tasks. On the other moved the supervisor of the lecture after many years. While the old manager was able to prepare the students optimally based on years of experience for the exam, the new manager had first to navigate in an orientation phase and was not able to point compared to before all possible pitfalls. After this familiarization phase, however, a significant increase in scores in

comparison to 2007 is observed, which indicates that the e-learning system has led to significant improvements in this event in the understanding, too.
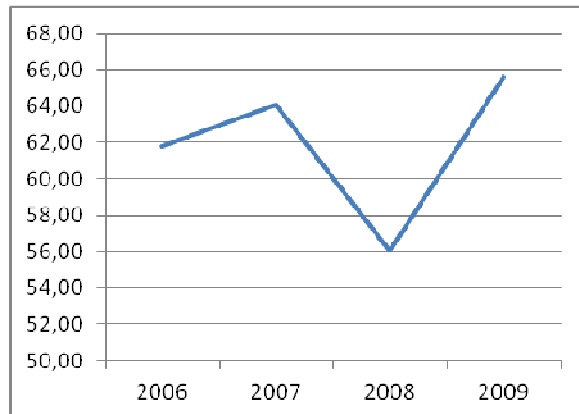

Figure 3: Development of the exam points databases and data modeling

In summary, it can be said that specifically appointed e-learning systems can sustainable increase the understanding of course content for students, if the system can be integrated seamlessly into the events and the educational aspect is adjusted accordingly. If this is not the case, such a system can also act counterproductive. Additionally, an e-learning system is also not a general purpose weapon that can replace events. The quality of a lecture is still largely determined by the lecturer.

References

[1] Bolliger, D. and Martindale, T. (2004). Key Factors for Determining Student Satisfaction in Online Courses", International Journal on E-Learning, (3), pp 61-67.

[2] Brusilovsky P. (1992). The Intelligent Tutor, Environment and Manual for Introductory Programming. Educational Technology and Training International, 29, (1), pp 26-34.

[3] Döring, N. and Fellenberg, F. (2005). Soziale Beziehungen und Emotionen beim E-Learning In: D. Miller (Ed.): E-Learning – Eine multiperspektivische Standortbestimmung, Bern 2005, pp. 134-155.

[4] Higgins, C., Gray, G., Symeonidis, P. and Tsintsifas, A. (2005). Automated Assessment and Experiences of Teaching Programming, ACM Journal on Educational Resources in Computing (JERIC), Vol. 5, issue 3, September, ISSN 1531-4278.

[5] Haack, J. (2002). Interaktivität als Zeichen von Multimedia und Hypermedia, In: Issing, L.J. and Klimsa, P. (Eds.), Information und Lernen mit Multimedia und Internet, Weinheim: BeltzPVU, pp 127-136.

[6] Issing, L.J. (2002). Instruktions-Design für Multimedia, In: Issing, L.J. and Klimsa, P. (Eds.). Information und Lernen mit Multimedia und Internet, Weinheim: BeltzPVU, pp 151-176.

[7] Kerres, M. and Jechle, T. (2002). Didaktische Konzeption des Telelernens, In: Issing, L.J. and Klimsa, P. (Eds.), Information und Lernen mit Multimedia und Internet, Weinheim: BeltzPVU, pp 267-281.

[8] König, M. (2001). E-Learning und Management von technischem Wissen in einer webbasierten Informationsumgebung, Duisburg: Druckerei Duennbier.

[9] Patel, A. and Kinshuk (1996) Intelligent Tutoring Tools – A problem solving framework for learning and assessment", In: M. F. Iskander et al. (Eds.): Proceedings of 1996 Frontiers in Education Conference – Technology-Based Re-Engineering Engineering Education, pp 140-144.

[10] Siepermann, M. (2005). Lecture Accompanying E-Learning Exercises with Automatic Marking", In: Richards, G. (Ed.), Proceedings of E-Learn 2005, Chesapeake: Association for the Advancement of Computing in Education, pp 1750-1755.

[11] Siepermann, M. and Lackes, R. (2007). Self-Generating and Automatic Marking of Exercises in Production Planning", In: Isaias, P., Nunes, M.B. and Barroso, J.: Proceedings of the IADIS International Conference WWW/Internet 2007, Vol. 2, International Association for Development of the Information Society, pp 13-17.

[12] Strzebkowski, R. and Kleeberg, N. (2002). Interaktivität und Präsentation als Komponenten multimedialer Lernanwendungen, In: Issing, L.J. and Klimsa, P. (Eds.), Information und Lernen mit Multimedia und Internet, Weinheim: BeltzPVU, pp 229-245.

[13] Wesp, D. (2003). Warum erfolgreiches E-Learning so selten ist- Thesen und Erfahrungen, In: Apel, H. and Kraft, S. (Eds.) Online lehren. Planung und Gestaltung netzbasierter Weiterbildung, Bielefeld 2003, pp. 173-180.