EMPIRICAL STUDY IN TEACHING FIRST-YEAR DATABASE STUDENTS

Sue Barnes
University of Worcester
Henwick Grove
Worcester, WR26AJ
s.barnes@worc.ac.uk

Joanne Kuzma
University of Worcester
Henwick Grove
Worcester, WR26AJ
j.kuzma@worc.ac.uk

ABSTRACT

This paper describes the authors' experience in team teaching two occurrences of a first-level undergraduate 'Database Applications' module. An analysis of the two occurrences revealed a difference in attendance, marks, seminar participation and attitude. This paper attempts to identify some reasons for this difference as well as reviewing some of the teaching activities that were used in this module. It analyzes the success of these activities and the perception and feedback from each group of students, and some possible recommended changes to the module.

Keywords
Database, student-learning, class activities.

1. INTRODUCTION

The database module reviewed in this paper is 'Database Applications' (COMP1112) and is aimed primarily at first-year students in the undergraduate Computing degree. Most students will take this module during the second semester of their first year, and then progress into more advanced database modules in their second and third year. It serves as the introductory module to database concepts and its objectives include the following:

1. Identify and access the benefits of database technology
2. Explain the principles of a relational database
3. Apply, with structured tutor support, design techniques to build a database application
4. Use SQL statements to retrieve information from a database

The learning and teaching is based on a series of mixed-mode lectures and seminars, with students attending a 3-hour session. The first hour of the session is lecture-based, and the students are exposed to a variety of database and SQL concepts and theories. The second part of the session is a 2-hour seminar conducted in a computer-lab where students gain hands-on experience with practice design and SQL exercises.

There were two occurrences for this module. One occurrence ran on Monday afternoons and had an enrolment of 33 students. The second ran on Thursday morning with an enrolment of 16 students. Students were able to choose which occurrence they registered on and after the start of the module given an opportunity to change group if they wished. The majority of students were enrolled on the single honours BSc Computing programme or an associated pathway with joint Business Management and Computing also represented. Most ranged from 18-20 years. There were 28 males and 5 females in the Monday occurrence, and 12 males and 4 females in the Thursday occurrence. In an informal survey taken at the beginning of the module, there was a mix of student experiences with database concepts. Most students had some level of exposure to database usage with MS Access in their A-level course of study. However, most of the experience was at the user-level of designing forms and working with the design aspects of Access. Few students had more than a cursory exposure to topics such as designing Entity-Relational Diagrams (ERD) or SQL coding. None of the students had any exposure to an Oracle database environment.

This module was conducted in a team teaching environment, with two instructors assigned to teach the lectures and seminars. Both were present throughout all sessions. The course materials (lecture notes, PowerPoint slides, Access files, SQL scripts) were available to students via the Blackboard online learning management system.

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2. TOPICS AND ACTIVITIES

2.1 Database Concept Topics

For this module, there was an option to either use Oracle or MS Access. The text chosen, *Database Systems: Design, Implementation and Management* by Rob, Coronel and Crockett [1] had exercises and SQL scripts for both DBMS. However, there were issues with getting the SQL Oracle scripts to run correctly, while the Access-based SQL scripts were correct. The logistics of correcting, de-bugging and re-trialling the Oracle scripts were beyond the timeframe assigned to the module delivery. Also, in an informal survey of students conducted at the beginning of the semester, no student reported any experience with Oracle, with all having at least some exposure to Access. It was therefore considered that it would be difficult for first-year students to learn both the Oracle environment as well as overall database concepts. Therefore, the decision was made to use Access for all exercises and assessments.

As shown in Figure 1, the first six weeks of the module dealt with basic database design concepts, such as database models, entity relations and normalization. The second half of the semester dealt with specific SQL concepts. Hands-on exercises and activities were incorporated into the seminars for each week.

Session	Topic	Activities
1	Databases: the basics	Misc Activities
2	File based systems	Understanding the terminology
3	The database model	Relational database activities
4	Entity relationships	ERD activities
5	Normalisation	Normalisation activities
6	Understanding schema	Logical model activities
7	SQL: an introduction	SQL activities
8	SQL	Practical
9	SQL	Practical
10	SQL	Practical
11	SQL	Practical

Figure 1: Session Topics and Activities

2.2 Class Activities

A variety of learning activities and games were incorporated into this module to increase the students' ability to comprehend and apply the concepts. Ruben (cited by Grabowski & Price, 2003) states that games, in general, are well known in education and widely exploited by science and technology curricula [2] [3]. Games can be designed to be very engaging while simultaneously challenging students to use their knowledge in novel ways and to test their knowledge of the subject content [3]. Because today's higher education students have grown up in a high technology environment, they are very *media savvy* and possess a high threshold for using multimedia presentations.

The first game played was *Find Your Mate*. This game was played during the first week of the five week SQL portion of the module. The aim of this game was to match SQL data types and type formats. The instructors divided 12 data type formats with an example of these types, as shown in Figure 2. For example, a data type of VARCHAR(25) should be matched with an example of 'LAST_NAME = Smith.' Each data type was written on a yellow sticky note, and the corresponding example was written on a pink sticky note. Therefore, all data types were on yellow notes while examples were on pink notes, for a total of 12 yellow and 12 pink matching notes. There were enough notes for 24 players, although this could be increased or decreased depending upon the number of students usually attending the seminar.

Data Type	Example
VARCHAR(25)	LAST_NAME = 'Smith"
DATE	BIRTHDAY = 08/01/2009

Figure 2: Data Types and Example

Before the beginning of the lecture, the instructors went into the classroom and randomly placed the sticky notes underneath the computer lab keyboards. After the end of the lecture and before the 20 minute break before the seminar session began, the instructors told the students they would be playing a *Find Your Mate* game and to look under their keyboards. They were instructed to walk around the lab and to find their matching data type or example. They would first look for the opposite note colour, and then try to match their respective types.

This game was geared to getting students to understand business examples of how data types can be used. After the students found their matches (or mates), the entire class went over each data type and the proposed example, and the reasoning for the match was explained, as well as other examples that could be used. For example, for a VARCHAR(25), business factors of the firm were discussed which would determine the length of this data type.

There was a large difference in the perception of this game by students in the Monday group versus students in the Thursday group. Some students in the Monday group seemed reluctant to participate in the game and several students walked out more intent on taking a break than participating in the exercise. Many of the other students then just milled about and did not want to walk around asking other students if they were a match: the impetus was lost. When the debriefing of the exercise began, students appeared uninterested in the concepts. This was in sharp contrast to the Thursday group. This group eagerly took the sticky notes from under the keyboards and immediately started to walk around trying to find their match. They also showed an interest in the debriefing and the class had an in-depth conversation on data type examples and differences that could be used in real business situations. The instructors were at a loss to explain the marked difference between why the exercise worked in one group and not the other.

The American TV game show *Jeopardy* was used as an activity with the SQL portion of this module. *Jeopardy* has been adapted internationally and takes the form of a quiz featuring a variety of trivia topics such as science, celebrities and sports. In the game show version each contestant is given an answer, and then the contestant phrases the answer with a question. The game format has been adapted by teachers who adapt their own questions and answers within a PowerPoint format. *Jeopardy* has been successfully used in other academic settings ranging from primary school to higher education, as well as in a variety of subjects. One case study of a group of chemistry students found that students had a positive experience with the *Jeopardy* game [3]. Some of the positive aspects included:

- Rather than normal passive regurgitation of concepts, the students found an interesting deviation from normal class learning;
- Students were challenged to use their chemical knowledge to answer questions;
- It offered a unique non-threatening insight to students as to what topics they still needed to learn;
- It helped students relax before exams because it reinforced how much they knew [3].

A second group of academics used the game for a pulmonary physiology course for first-year medical students with positive results [4]. Thus, this game can be used for a wide variety of subjects ranging from primary school up to post-graduate student levels.

The *Jeopardy* game under discussion was created using Microsoft PowerPoint. The first slide contained the answer board for the game and is shown in Figure 3 with the five categories of questions being:

- Introduction to SQL;
- Creating a database;
- Data types;
- Constraints;
- Indexes and table rows.

The categories were taken from the SQL concepts discussed in the lecture for that week and referenced to the module key text pages. Specific questions for each category were created and given a point value ranging from 10 to 40 points, in increments of 10. Questions with the point value of 10 were ranked as *easier* questions, while those in the 40 point category were considered more *difficult* questions. Each question would also have an associated answer. For example the questions and answers for the *Constraints* category are shown in Figure 4.

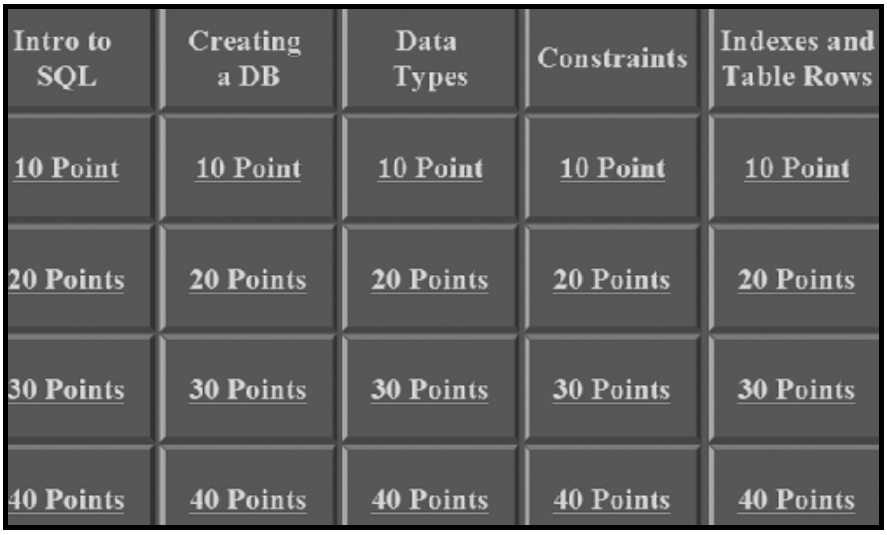

Figure 3: Jeopardy Answer Board Slide

Each cell of the answer board would link directly to the specific question associated with that cell and points. The students would see the question for that slide and provide an answer. After the students provided this, the instructor would click to the next slide, showing the correct answer and page in the text [1] where the answer could be found. It should be noted that categories and questions could easily be changed to include other topics within the database arena, or even other classes ranging from astronomy to electronic commerce. Also, PowerPoint is flexible enough so that the number of categories and rows could be expanded or deleted.

Points	Question	Answer
10	True/False - CHECK is the constraint used to validate data in an attribute	True - Page 293
20	_____ specifications for the attributes ensure that a data entry is made	NOT NULL - Page 303
30	_____ specification is used to avoid duplicated values in a column	UNIQUE - Page 304
40	True/False - A RDMS automatically enforces referential integrity for foreign keys	TRUE - Page 304

Figure 4: SQL Questions and Answers

In order to set up the game for the class, the instructors divided each class into a specific number of teams. This could vary depending upon the total number of students who attended that week's seminar session, and which was usually four or five students per team. The directions were explained, and the teams had to do some strategic thinking about whether to try to answer a *difficult* 40-point question which could result in a higher than average probability they would answer the question incorrectly, versus picking a 10-point question with a better chance of answering correctly. Each team was then allowed to choose one question to answer in a round-robin approach. In this case, there were four iterations of question and answer sessions. Once the team gave their answer to the question on the slide, the instructor clicked on the link to the next slide where the correct answer and text page was found. The entire class went over the SQL question in detail so all students understood the concept, especially if the team answered the question incorrectly.

This game was played during the second week of a five week SQL instruction during the second half of the semester. By the end of the second week, the students were well into basic SQL concepts and constraints, so this was considered to be a good time to play the game. The game was very well received by the students and there were many positive comments about it, and the instructors learned some valuable lessons. Firstly, students liked that the game was played in a team environment as opposed to an individual format. This way, the team could collaborate on an answer, and one student would not stand out to the class if they did not know the answer. In addition, both the Monday and the Thursday group viewed the exercise positively. Secondly, the faculty gained feedback on what topics the students knew well and with which concepts they were having trouble. For example, there were several questions that both the Monday and the Thursday group did not answer correctly. This helped the instructors to determine upon which topics they should have spent more time to lecture.

3. ISSUES AND PROBLEMS

At the beginning of this module, the instructors assumed that both classroom occurrences would have the same attitudes, attendance and assessment percentages. It was believed that since both groups were first year students and mostly on the same computing programme, there should be minimal differences. However, it was surprising when this turned out otherwise.

The first difference noticed with the groups was the level of attendance. The Monday occurrence had 33 students enrolled, with an average of 23 (71%) showing up for the one-hour lecture, and 13 (40%) attending the two-hour seminar. The Thursday occurrence had 17 enrolled, with 14 (82%) attending lecture and 13 (76%) attending the lab seminar. For the Monday occurrence, a large percentage of students left immediately after the lecture and did not bother to attend the lab seminar, while this did not occur with the Thursday group, where most students stayed for both lecture and seminar.

A marked difference in attitude existed between both occurrences. The instructors found several of the students in the Monday lecture continually talking during the lecture and causing a disruption for other students. This group of students usually left immediately after the lecture and never attended seminar labs. Some of the students in this occurrence also expressed a marked reluctance to answer impromptu questions during class, or a lack of excitement about or engagement with most exercises. The only activity where they showed enthusiasm was the *Jeopardy* game. This was a marked contrast to the Thursday group who would usually answer impromptu questions and were enthused with most activities and willingly participated in discussions.

There was also a slight deviation in the marks between the groups. Figure 5 shows the distribution of the marks for the first assessment, which covered design concepts and entity-relationships. The first column shows the available marks (A - F), with an NS being a non-submittal. The second column shows the number of students in the Monday occurrence who received a specific mark, while the third column shows the distribution for the Thursday occurrence. The table shows that the students in the Monday occurrence had a pronounced deviation of marks, with more students either receiving very good or very bad marks. Alternatively, the Thursday occurrence had a much more even distribution of marks. The Monday group also had a lower average mark of 11.7 average points, correlating to a C-/C, while Thursday showed an average marking of 12.4, which is a high C.

Mark	Monday (assignment 1)	Thursday (assignment 1)
A+	0	0
A	4	1
A-	1	1
B+	0	2
B	1	1
B-	0	2
C+	2	0
C	5	1
C-	2	2
D+	3	2
D	1	0
D-	6	1
E	4	2
F	0	0
NS	4	1
Average	11.7=C-/C	12.4 = C/C+

Figure 5: Assessment 1 Grade Profile

Again for Assignment 2 there is a slight deviation in the marks between the Monday and Thursday groups. Figure 6 shows the distribution for this assignment, which covered the use of SQL. This shows that the grade distribution was A+ through F, with an average of B+ for Monday and A- for the Thursday group. For this assignment the grades are skewed to the higher end despite the fact that students found SQL concepts challenging during the weekly sessions. Students have linked their engagement with this topic to the *Jeopardy* game where they were able to test their understanding in a relaxed environment.

Mark	Monday (assignment 2)	Thursday (assignment 2)
A+	5	7
A	9	3
A-	8	2
B+	0	0
B	0	1
B-	0	0
C+	1	0
C	1	0
C-	0	0
D+	1	1
D	0	0
D-	3	0
E	0	0
F	1	1
NS	4	1
Average	15.7 = B+	16.7 = A-

Figure 6: Assignment 2 Grade Profile

It is believed there were a variety of reasons for students' had different attitudes and deviation in marks.

- There was a poorer attitude towards learning exhibited by some students in the Monday class. This was evident when some students talked to neighbours and disturbed students trying to concentrate;
- There was a mix in the database experience of the students. However, surprisingly, it was found that students who came in with more MS Access experience struggled more because they thought they knew the subject better than they actually did;
- There was an inherent difficulty in the subject matter itself. Some students struggled more with conceptual design because it is not a black-and-white area, while SQL coding was more definitive. There were some problems dealing with abstract concepts in the first part of the semester, which manifested itself in the assessment marks awarded;
- There was also an issue with students wanting black and white answers to design problems. They had to be repeatedly told that a lot depended on the business situation. For instance, the number of appropriate characters for the design of the *telephone number* field depends upon in what countries you are doing business. This may have been caused by a lack of business experience;
- There were problems with the textbook containing incorrect answers to problems. This caused a great deal of student and instructor frustration.

At the end of each semester students complete a questionnaire which informs further developments. This, together with informal feedback gathered during the module indicated that students were very satisfied with the module, especially with regard to the support offered by the tutors and learning activities. However with reference to the physical accommodation, some of the Monday group did not like the lecture theatre used for the first part of the afternoon. Half way through the module the group moved to a computer lab for the whole session. This lab was used throughout on Thursdays and engendered a friendlier atmosphere. The may also be a factor is student engagement and participation.

4. CONCLUSION

This paper describes the learning experiences of two occurrences of a first-year database module. The authors had different experiences regarding attendance, marks, participation and attitude. *Fun* activities were incorporated into seminars to help disaffected students to engage with their learning. Informally, most students expressed a positive reaction to game-based learning activities and reported that the games had helped conceptualise ideas and knowledge. In addition the faculty was able to review what topics the students knew or were having issues with. However, no study was made to determine if students who had specifically participated in the seminar games tended to receive higher marks on assessments compared to students who did not participate in the games and seminars. This could prove a difficult correlation because it might be expected that any student attending a seminar automatically participated in the games, and would therefore automatically have a firmer grasp of the materials than a student not attending a seminar session. A further study may be developed to determine if the game activities actually did contribute to students' overall knowledge of the topic. Another issue raised was the difference in learning and assessment marks between

the two occurrences, with several factors contributing to this difference. The Thursday group appeared to offer mutual support with activities and showed more engagement and willingness to participate in discussions.

5. REFERENCES

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