PRACTICE AND THEORY: MIXING LABS AND SMALL GROUP TUTORIALS

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ABSTRACT

While appropriate for practical topics like SQL, our traditional format of lecture and lab fails to facilitate the discussion of more theoretical database topics with students. This paper describes and analyses the method and effects of adopting a more flexible approach with third year and postgraduate students. Some weeks use supervised labs while in others tutorials are held in seminar rooms, in smaller groups, without the distraction of computers. Requiring tutorials to be prepared in advance allows time to be used effectively, concentrating on more difficult aspects.

Initial results, presented in this paper, are encouraging. Many students enjoy tutorials and exam performance has improved dramatically for some. However, as many as 25% of undergraduate students failed to attend a single tutorial, and many of those who did attend came unprepared. Could, and should, this be changed by explicitly assessing tutorials? The paper concludes by investigating approaches reported elsewhere in order to ascertain how the management of tutorials could be improved.

Keywords

Teaching, learning, delivery, syllabus.

1. INTRODUCTION

In our school, the traditional format for class contact in computing modules comprises a weekly one-hour lecture, which is supplemented by a two-hour lab. Lectures are delivered to whole cohort, whether 30 or 150 students, while labs are held in groups of 20-30 students depending on the size of available rooms.

But is this the best teaching style for database modules? In our experience, practical subjects such as SQL work well with this model, as students can use a real DBMS to try out their solutions. In two hours, plenty of time is available to complete a substantial number of exercises. Homework is deliberately limited to follow-up exercises rather than preparation, as we have found that many students were so discouraged by errors that they failed to complete preparation work.

We teach 'classic' database modules to third year BSc students in Computing, Computing (Applications Development), Information Management and Business Computing, and to postgraduate MSc Information Technology and Bioinformatics students. Both sets of students study two articulated database modules spanning semesters 1 and 2, totalling 24 credits for undergraduates and 30 credits for postgraduates. While up to half of the material covered is practical, like SQL, all modules also address more theoretical aspects such as concurrency and distributed databases. Some practical topics, such as logical database design, are not underpinned by any software. The content generally follows selected chapters from [2]. Figure 1 shows some typical exercises given to the students.

Practical (software)	Write SQL for the following query: Find the customers who have spent more than average.
Practical (pen and paper)	A ward has many nurses and each nurse may work in several wards. Draw an entity relationship model for this scenario and sketch an appropriate database schema.
Theory	Discuss the two-phase locking protocol in the context of transaction management.

Figure 1: Sample exercises for different topic types

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In the past, theory and pen and paper exercises were also used in labs; for example, students were given 10 minutes to tackle each question before the answer was demonstrated on the whiteboard, and encouraged to work in groups of two or three. However, there were several problems observed with this approach:

- Many students were distracted by the presence of computers and failed to engage or even listen;
- The physical lab environment provided little workspace and often only small whiteboards.
- As students worked at markedly different speeds, it was difficult to judge when to move on to discussing the question with the class;
- Despite encouragement, many students were reluctant to speak out and avoided contributing to the solution;

This led us to trying a different approach two years ago, by introducing tutorials to support theory and pen and paper exercises. The approach is presented in the following section, while the remainder of the paper presents an analysis of its effects.

2. INTRODUCING TUTORIALS

For postgraduate students, tutorials were introduced at the beginning of session 2002-3. After initial positive results, third year modules followed in semester 2.

Tutorials are held in smaller groups of around 10-12 students and timetabled in small seminar rooms, which have no computers. This addresses the first two problems listed above and encourages students to participate more freely. Students are also asked to attempt all exercises *prior* to the tutorial. This reverses previous practice of giving homework after class and addresses the last two points above, as it allows students to plan their contributions in advance.

2.1 Timetabling models

Where introduced, one hour tutorials replace approximately half of the scheduled two hour labs. Hence class contact for students is reduced slightly, but smaller groups and preparation allow for a more efficient use of time. For staff, class contact is unchanged, as each lab group is split into two for tutorials. Figure 2 shows two different timetabling models. For simplicity, only one lab group A is shown; A is split into subgroups A1 and A2 for tutorials.

In Model 1, all students have either a two hour lab or a one hour tutorial in addition to the weekly lecture; this is scheduled according to the types of topic covered in the lecture – labs follow computer-based topics like SQL while tutorials are chosen for pen and paper practical topics and theory. In Model 2, all students have a lecture and a one hour lab each week, in addition to fortnightly tutorials.

Model 1	Week x	Lecture	Lab group A	
	Week y	Lecture	Tutorial group A1	Tutorial group A2
Model 2	Week 1	Lecture	Lab group A	Tutorial group A1
	Week 2	Lecture	Lab group A	Tutorial group A2

Figure 2: Two timetabling models

2.2 Discussion of models

Model 2 has been used with postgraduate students, Model 1 with undergraduate and postgraduate students. Both models have advantages and drawbacks.

The main advantage of model 1 is its flexibility, allowing the method each week to be selected as appropriate to the topic covered in the lecture. All students have approximately the same preparation time.

Disadvantages are that the students' timetable varies from week to week, leading to a small administrative overhead in ensuring students know where to go when. In addition, while the same number of rooms are required for the same times each week, different types of room are needed. Timetabling for the University as a whole thus becomes more awkward. Unless both seminar rooms and labs can be reserved every week, the delivery schedule must be thought through carefully prior to timetabling. An unexpected side effect of model 1 and small groups is also that tutorials can become very repetitive for staff, making it difficult to show enthusiasm with group J towards the end of the week.

Model 2 shows the advantages that students have a fixed (fortnightly) timetable, with well dispersed preparation requirements, and the same rooms are needed each week. As only half the tutorial groups meet each week, this model is less repetitive for staff. On the other hand, scheduling of module content needs to be done early and carefully to allow all groups enough (but not too much) time for preparation between lecture and tutorial. Another serious disadvantage is that students tend to achieve much less in two one-hour labs than in one two-hour lab.

3. STUDENT FEEDBACK

At the end of Semester 2, third year students were asked to complete a detailed, anonymous questionnaire in WebCT. To date, 67 students have completed the survey. This represents completion

rates of about 40% and 30% in 2002-3 and 2003-4 respectively.

3.1 Tutorial feedback

As tutorials were new, the survey concentrated on questions which would allow students to express their opinions in detail. Overall, the feedback for tutorials was encouraging (see Fig. 3), showing that most students found the tutorials useful exam preparation and liked the style. Speed and difficulty were rated appropriate. While most students enjoyed the tutorials and only very few said the opposite, a large minority (about 25%) of the respondents said they did not always attend.

Preparation for the tutorials received the worst rating – only 14% of students strongly agreed they always prepared, whereas 23% confessed to not preparing for tutorials as requested.

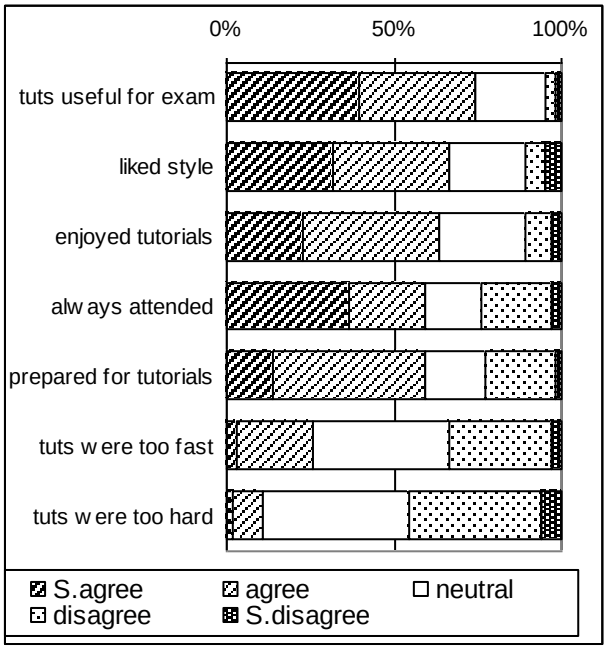

Figure 3: Tutorial feedback

Students who prepared regularly found the tutorials significantly more enjoyable than those who did not (χ^2=22.83, df=1, p<0.001)[1]. Unfortunately, the available information does not allow any conclusion as to whether preparation was the cause or effect of enjoyment. One student, who did not prepare regularly, said "the teaching style involved in the tutorial was extremely poor and I found it difficult to concentrate and learn." Students who enjoyed the tutorials felt more strongly that tutorials would be useful preparation for the exam (χ^2=15.92, df=1, p<0.001) and showed better attendance (χ^2=10.35, df=1, p<0.01).

[1] Due to sample size, categories were grouped into strongly agree/agree and neutral/disagree/strongly disagree respectively for all χ^2-tests.

However, the association between attendance at tutorials and usefulness rating was statistically not significant (χ^2=3.04, df=1, p>0.05). Of the students who did not attend regularly, 63% did so despite perceiving tutorials as useful. We also found no significant association between preparation and usefulness rating (χ^2=3.04, df=1, p>0.05).

3.2 Labs and tutorials compared

The survey asked students whether they enjoyed and attended labs and tutorials. In agreement with actual attendance records, more students said they attended labs than tutorials (see Fig. 4). In contrast, more students said they enjoyed tutorials than labs. This result was unexpected. Another unexpected result was that students felt tutorials would be more useful preparation for the exam than labs were for the coursework, despite completing the survey before the exam took place.

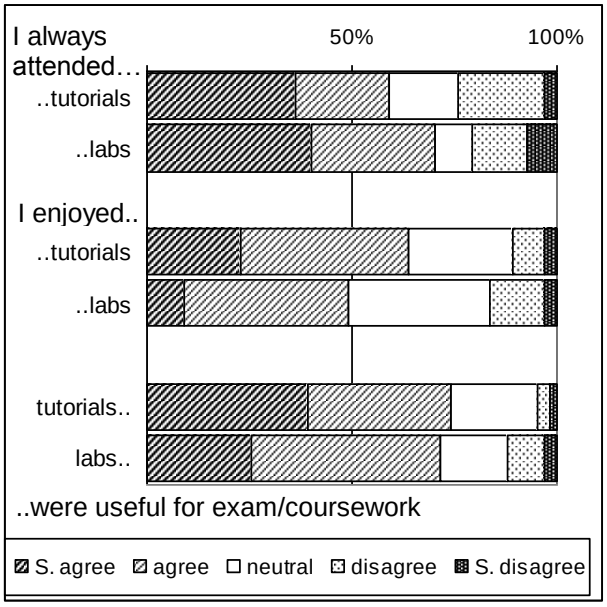

Figure 4: comparison of tutorials and labs

The students who enjoyed tutorials and labs were mostly identical (χ^2=6.55, df=1, p<0.05), although 16 students enjoyed tutorials but not labs and only 7 enjoyed labs but not tutorials. This result came as a surprise, as students usually appear to prefer "practical" topics to "theory".

Another surprising result was the difference in labs and tutorials with respect to enjoyment and attendance. For tutorials, there was a significant association between the two (see previous section). However, surprisingly, for labs enjoyment and attendance were completely unrelated (χ^2=0.206, df=1, p>0.6) – students attended labs whether they enjoyed them or not.

4. MEASURABLE EFFECTS

Trying to find ways of helping students perform better was the main aim behind the introduction of tutorials. So has this aim been achieved?

4.1 Effects of introducing tutorials

For third year students, tutorials were first introduced in semester 2 2002-3. As all students taking Databases for Large Systems in S2 also studied Designing Databases in S1, with identical module tutors, textbook and similar exams, their performance can be compared directly. After excluding any students who failed to participate in one of the exams, the results of 69 students taking both modules were compared. The mean examination grade improved by nearly a grade, from 9.90 to 9.13[2]. This is statistically significant ($t=2.485$, $df=68$, $p<0.01$). The difference was particularly marked for weaker students, some of whom improved by 5 grades or more. (see Fig. 5). However, not all students improved. A comparison of S1 exam grades between the sessions prior to and after the introduction of tutorials also shows an improvement of around half a grade in the exam average, from 10.23 to 9.79.

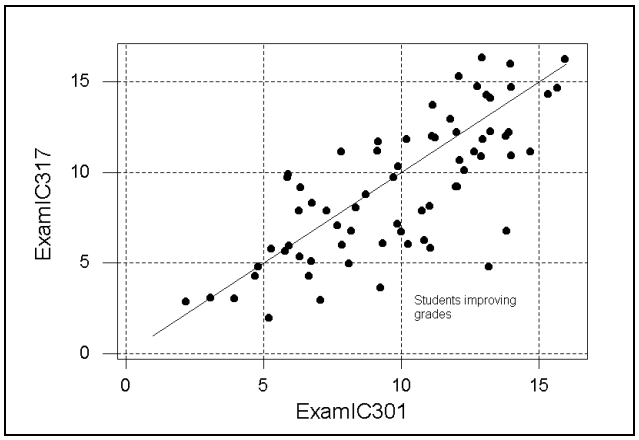

Figure 5: Comparison of S1 (IC301) and S2 (IC317) exam grades

Although data for postgraduate students is not available, the two most recent cohorts who have experienced tutorials have given exam answers of greater depth and shown a higher standard of critical discussion than previous cohorts.

4.2 Tutorial attendance

In Data Modelling in S1 this session, six tutorials were held. Three covered entity relationship modelling and logical database design, which was assessed by class test in the following week. The remaining three covered normalisation, relational algebra and physical database design, all potential exam topics. Attendance records and results for the 130 students of this module are shown in Fig. 6.

Number of relevant tutorials attended	0	1	2	3
Mean exam grade	11.88	10.75	8.82	7.23
Mean test grade	7.94	5.75	4.71	5.11

Figure 6: Attendance and performance[2]

An analysis of assessment grades shows the more relevant tutorials students attended, the better they performed in the exam ($F=3.17$, $df=3,49$, $p<0.05$).

As expected, the grades achieved in the class test were also markedly better for students who attended at least one tutorial. Unfortunately, it is impossible to tell whether students preparing for the tutorials performed better, as no relevant data are available.

5. DISCUSSION

We have shown in sections 3 and 4 that on the whole, students responded positively to the introduction of tutorials, giving good feedback and showing improved performance. As contact time per student is one hour for tutorials but two hours for labs, the class size can be halved without requiring additional staff time, making tutorials cost-neutral in terms of time. However, there are a number of issues in addition to those discussed in section 2.2 which have become apparent and should be addressed.

5.1 Attendance

Postgraduate students generally showed excellent attendance in tutorials. However, for third year students attendance in tutorials was somewhat patchy and much lower than attendance in labs. On average, students attended 3.58 out of 5 labs but only 2.98 out of 6 tutorials. Often tutorials were held for only half a dozen or even fewer attending students.

classes attended	0	1	2	3	4	5	6
..out of 6 tutorials	30%	14%	7%	14%	14%	23%	20%
..out of 5 labs	4%	9%	8%	17%	28%	34%	n/a

Figure 7: Tutorial and lab attendance compared

What can be done to improve attendance in tutorials? Postgraduate students were assessed on tutorial participation in semester 1, partly on oral contributions and partly on a short written reflection following their presentation of an exercise answer in class. But if direct assessment is a crucial factor in encouraging students to attend, then why did postgraduate students attend equally well in

[2] At Abertay, grades 1-10 are pass grades, 11-16 fail grades, 18 non-participation.

semester 2 when tutorials were not explicitly assessed?

5.2 Engagement and participation

Postgraduate students usually came to classes prepared, and were keen to participate. By contrast, despite requiring preparation of exercises for the tutorial, many undergraduate students came to tutorials unprepared. In the survey (see section 3.1), around 25% of students admitted to this approach, while only about 10% said they always prepared. Lack of preparation had clear consequences in students sitting in class listening, but unwilling to contribute. Voluntary contributions tend to come from the same few students each time.

We introduced a rule experimentally of barring students' admission to tutorials if unprepared. While this improved the attitude of some students, the approach backfired for many who simply stopped attending altogether instead of preparing for the next tutorial. This approach was also discontinued because staff preferred to offer students the opportunity of attending in the hope students would gain some benefit even if unprepared.

6. THE WAY FORWARD

What can we do to improve? Are our results typical for the sector? This section investigates student motivation and approaches to encouraging attendance and participation tried elsewhere.

Our tutorials are not unique among database modules. For example, [8] uses tutorials with MSc students, while [3] provides tutorial support to help with a case study and exam preparation. While there is some overlap in the purpose of tutorials, our model contradicts their conclusion that tutorial support provided was “inadequate by definition” [3] due to large class sizes. Unfortunately, neither [3] nor [8] discuss tutorials comprehensively, so we turn elsewhere for inspiration and ideas.

Although [1] do not use tutorials, they report how they solved a participation and engagement problem affecting their weakest students in a programming module, who failed to benefit from the provision of otherwise successful online materials. They discovered that problem was caused by these students not completing homework. This is similar to one of the issues we have encountered. [1] solved the problem by assessing homework regularly for participation, and making it worth a substantial proportion of the module. This was enabled by using RoboProf, a teaching tool which was used to mark homework automatically and provide feedback. If students failed to do the homework, they were put on the spot in class either as part of a group exercise or by holding unannounced class tests. While successful in the context of the US Military Academy West Point [1], we suspect that this carrot and stick approach would not work with our students, who are free to not attend. This suspicion is underpinned by [5], who advise against penalising non-academic behaviour and describe how assessing homework as a large proportion of a module can lead to non-completion through fear of failure. There is a substantial body of literature about student motivation. Although our tutorials achieve some of the points raised, [4], [5], [6] and [7] provide inspiration for improvement.

- Variety increases motivation [5]. Adding tutorials as a third type of class in addition to lectures and labs increases variety. However, it would be good to also strive for a variety of approaches within tutorials, perhaps mixing presentations, group and individual work and discussion.
- Students strive for individualised instruction and attention [7] and feedback [5], justifying the small group size of our tutorials. One student said “in the tutorials you had the lecturers undivided attention and if you had any questions it was much easier to get their attention [than in labs]. The tutorials were particularly helpful with the exam. The questions managed to incorporate almost all of the subject we would be covering in a certain tutorial. I found going over the exam technique very helpful when it came to the exam”. Maybe we should make groups even smaller? Tutorials in groups of 5 students have proved effective with first year Computing students at Abertay [MacEachen, personal communication] and [4] agrees that a group size of 5-8 optimises the trade off between variety of knowledge and opportunity for individual oral contribution.
- Students need to know the ground rules and our expectations [6]. We currently explain these in a lecture, but actually discussing them with students in the first tutorial and letting them suggest their own could boost ownership and therefore compliance.
- Students are afraid of exposing themselves in public [6]. Allowing sufficient time for preparation and small groups should minimise this problem. Ice-breakers and other exercises could be added to establish good practice and facilitate participation.

We have found that not all students prepare their homework. [5] proposes an idea which improved homework completion from 10% to 90%. The survival card method allows students to hand in a small handwritten card with outlines and key points at the beginning of class (i.e. their homework). This is not graded, but stamped and returned to the students for exam preparation, where they can add and change the content of the cards, but not add more cards. The cards are handed in again and distributed back to students during the exam. Students who fail to prepare for classes or have not attended will not have survival cards. This method

appears to be an excellent idea, rewarding students substantially for weekly work and attendance and discouraging cramming. The only drawback is the administration of such a scheme with a large class.

On the other hand, perhaps we should stop whingeing about lack of preparation and work around this phenomenon. A practical example of managing classes where only some students have prepared is given by [4]: Draw up a list of questions at the beginning of the tutorial. The lecturer then presents the solution to one question in detail, encouraging students to shout out answers. Students then work on subsequent exercises in pairs while the lecturer goes round. When common problems arise, a student who is known to have arrived at the right answer is asked to explain. This model could work well for database topics such as modelling and normalisation, where tutorials consist of a number of similar questions and answers are either wrong or right.

7. REFERENCES

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