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Online Lecture Review Quizzes as a Study Aid

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Lecturing is the traditional way that students are taught at universities. The format affords an individual teacher the ability to address a large number of people and thus reduces the number of persons required to teach a large course. The effectiveness of the traditional lecture is widely contested however: Bligh (1998) outlines a number of problems with lectures and then goes on to argue that if lectures are not replaced outright they must be combined with other methods of teaching; Gibbs (1981) presents 20 reasons for why lecturing is, in his own words, "terrible"; and Mazur (2009) has shown that despite good evaluations, final exam performance suggest that lectures do not promote the desired learning outcomes.

This paper describes lecture review quizzes, introduced in an effort to address some of the problems with lectures, in particular trying to provide students with an opportunity to re-engage with the material after class. The quizzes were introduced into the 2010/2011 Datanet (Computer Networking) course at the University of Copenhagen, along with a large change in the compulsory assignments, described briefly in the background section. After providing background, the paper will focus on the on-line, multiple-choice lecture review quizzes and address the question: are online lecture review quizzes an effective way of making students re-engage with the lecture material?

2.1 Background on the Course

The computer networking course (Datanet) is a compulsory second year undergraduate course at the Computer Science Department at the University of Copenhagen. It has run largely unchanged for a number of years based on various editions of the book Computer Networking — A Top-Down Approach by Kurose and Ross. The course uses the lecturing material accompanying the book as well as the provided problem sets for the exercise classes. Assignments mainly test the practical aspects of the course (network and distributed programming) and the two hour written exam addresses the more theoretical aspects.

The author took over the course in the 2009/2010 academic year and delivered the course in Danish, but all teaching materials were in English: the textbook, auxiliary reading materials, slides, problem sets, and assignments. The exam was provided in both Danish and English (with identical questions) and the students were able to choose to answer the entire exam in either Danish or English.

The course in 2009/2010 resembled that of previous years (before the author took over the course). However, some material (mainly that on routing algorithms and wireless networks) was replaced with a section on distributed systems (which is not covered by the textbook). The distributed systems portion of the course replaces the distributed systems course that was previously offered at the Computer Science Department. The additional material lead to a change in the assignments such that two out of the total of four assignments were reworked to relate to the distributed systems part of the course (which is not covered in the exam).

The 2010/2011 academic year saw two major changes: the two distributed systems assignments were changed substantially; and lecture review quizzes were introduced (the main topic of this paper). Both changes were introduced in the planning stage of the 2010/2011 Datanet course, before the author started on the university didactics course. During the university didactics course a number of smaller self-contained changes were applied, mostly in the context of a number of specific lectures. These small experiments will not be discussed further in this paper.

The distributed systems assignments from the 2009/2010 course had students build clients for a trivial distributed system, which they tested by running three instances of their clients on their own computer. This simplistic approach runs contrary to a real distributed system, i.e., a system that consists of many interconnected clients running on a potentially large

number of different physical computers.[1] Limiting the interactions that a student's work must have with the outside world omits a large, and important, part of the learning experience surrounding distributed systems. This apparent deficiency, and the authors interest in constructionism[2] as described and eloquently applied in Resnick's *Turtles, Termites, and Traffic Jams* (1997) motivated a complete overhaul of the distributed system assignments.

Inspired by the authors previous work in creating constructionist assignments and learning experiences (e.g. *Patterns for programming in parallel, pedagogically* (2008)), the assignments were changed so that students had to build a client for an almost real[3] system: a distributed anonymising web-proxy, a somewhat simplified version of the Tor[4]system. In the new assignments each student's client must be able to interact not only with itself, but also all the clients written by all the other students on the course. The students must deal with real issues, such as incorrectly implemented clients and network disconnections, and document these and possible solutions in their assignment reports. The goal of redesigning these assignments were to make them more constructive i.e., making the assignment more meaningful and, at least potentially, useful to the student. While at times the unsanitised environment in which students had to build their work was clearly frustrating, the assignment reports suggests that students have experienced and managed much more authentic distributed systems problems than in the previous year.

2.2 Lecture Review Quizzes

The second change in the 2010/2011 course was the addition of lecture review quizzes. These on-line quizzes follow up on the material presented in lectures. The quizzes were voluntary and the intention was that they form part of the formative (self) assessment of the students. Currently the students obtain formative assessment by going to the exercise classes and in

[1] Skype, BitTorrent, and World of Warcraft are examples of contemporary distributed systems.

[2] Papert's constructionism builds on the ideas of Piaget's constructivism.

[3] The assignment can be seen at the following URL: http://christian.lyderjacobsen.org/portfolio/datanettracker/

[4] The Tor onion routing project: https://www.torproject.org/

the form of the marked assignments (which in general provide a considerable amount of feedback, though the actual amount does of course vary depending the person grading a particular assignment). Along with the exam the compulsory assignments form the summative assessment for the course.

The primary motivator for creating the quizzes was to provide a quick way for students to re-engage with the lecture material after the lecture has finished. The aim was to increase knowledge retention after the lecture, but without using the quiz during the actual lecture. Biggs & Tang (2007) briefly discuss the positive effect of actively engaging in the material at the end of and/or after the lecture.

As the quizzes are online and strictly multiple choice they can be assessed automatically and feedback about correct and incorrect answers can be provided instantly to the student. Student can use this assisted self-assessment in order receive reasonably objective feedback about their understanding of the covered material. This supplements the chapter review questions in the textbook (which does not provide model answers) and the exercise classes which also covers lecture review questions, though more selectively. The intention of providing the quizzes was that the students should do the quiz shortly after the lecture in order to help them identify focus areas that they need to review.

Initially the quizzes were made available for a limited amount of time in order to encourage students to take the quiz shortly after the lecture. The idea was that they would then be put online again close to the exam where they would be available as a tool for exam preparation. However after some discussion with students and instructors on the course it was decided, when the third quiz was published, that the quizzes would be available throughout the course with students able to take the quizzes as many times as they wished.

The quizzes ran for the first seven lectures, covering the core parts of the networking course. The distributed systems topics, as well as the security and cryptography sections were not covered by the lecture review quizzes. Covering the later parts of the course were, mainly due to time constraints, not planned for the 2010/2011 course.

The quizzes did, in general, not attempt to provide concept questions as those used prominently in, for example, Mazur's teaching (2009) but instead provide a larger set of small multiple choice questions related to the material in a specific lecture. Concept questions are also used in a significantly different setting: Mazur has changed the format of the lecture to be guided by asking multiple choice concept questions and letting students dis-

cuss their answers amongst themselves in order to improve understanding. This is in contrast with the lecture review quizzes presented in this paper, which are used in the students own time, after the lecture has completed.

2.3 Examining the Students Use of the Quizzes

In order to provide for their intended use, the quizzes would ideally have been put on-line and made automatically available at the end of each lecture. This of course relies on the quizzes having been prepared well in advance of each lecture. While a large amount of the work in preparing the quizzes was completed before the course started, the workload during the course unfortunately meant that some quizzes were severely delayed in relation to the lecture which they covered. Figure 2.1 shows that for the majority of the quizzes the delay was either zero or just over a week. It is clear however that the quizzes for Lecture 5 and Lecture 6 presented significant problems. The delays in publishing these two quizzes where due to the large amount of work required in preparing the infrastructure for the new distributed systems assignment discussed earlier.

Quiz name	Delay (in days)
Lecture 1	0
Lecture 2	0
Lecture 3	4
Lecture 3/4 DNS	8
Lecture 4	8
Lecture 5	39
Lecture 6	36
Lecture 7	0

Fig. 2.1. Delay between lecture and publishing of a quiz (in days).

Even if students had wanted to use the quizzes as intended (as a review tool shortly after the lecture) this would at times have been impossible. Looking at the data collected from the quizzes, it can be seen that students did in fact start out by taking the quizzes very close to the lecture, but this practice quickly faltered.

Figure 2.2 shows the distribution of students taking a particular quiz on a particular day. The charts show the number of of times the quiz was taken

on a particular day (a dark grey bar), the days the quiz was available (the non-greyed out area), and the date of the lecture to which the quiz relates (the black line). The dark grey bars represent the number of times the quiz was taken on a given day and not the number of students taking the quiz, as a student is able to take the quiz as many times as he or she desires.

The first day on the chart represents the first lecture of the course and the last day represents the exam. The date labels on the chart are one week apart, except for the last date, the date of the exam. One student used the quizzes before the resits for the course, but this has not been included in the charts. While the quizzes are not anonymous, the exam is, and it is therefore not possible to correlate the results or use of a quiz, with a final exam score.

While the number of students taking the quizzes as a lecture review exercise is not encouraging, the number of students using it for exam review are significantly higher. The number of students using each quiz in the week before the exam lies between 20–24. This represents just under half of the students who actually took the exam (52). The number of students taking each quiz can be seen in Figure 2.3.

2.4 Evaluations

A further source of information about the use of the quizzes are the compulsory anonymous course evaluations that must be provided to students at the end of a course (but before the exam). Unfortunately the online teaching environment on which these evaluations are distributed was suffering from severe performance problems around the time of the evaluations, resulting in the course receiving feedback from only 10 out of the 52 students who completed the exam. With so few respondents it is hard to say how representative the answers are of the whole student body, though there are perhaps still some interesting observations that can be made from the data:

- Very few students answered positively to using the quizzes as lecture review, corroborating the data in Figure 2.2.
- No student answered positively to whether the on-line lecture review quizzes to helped supplement the books lecture review questions. This may suggest that the students do not use the books own review questions. A future questionnaire could explore the methods students use the review the material covered in lectures, if any.

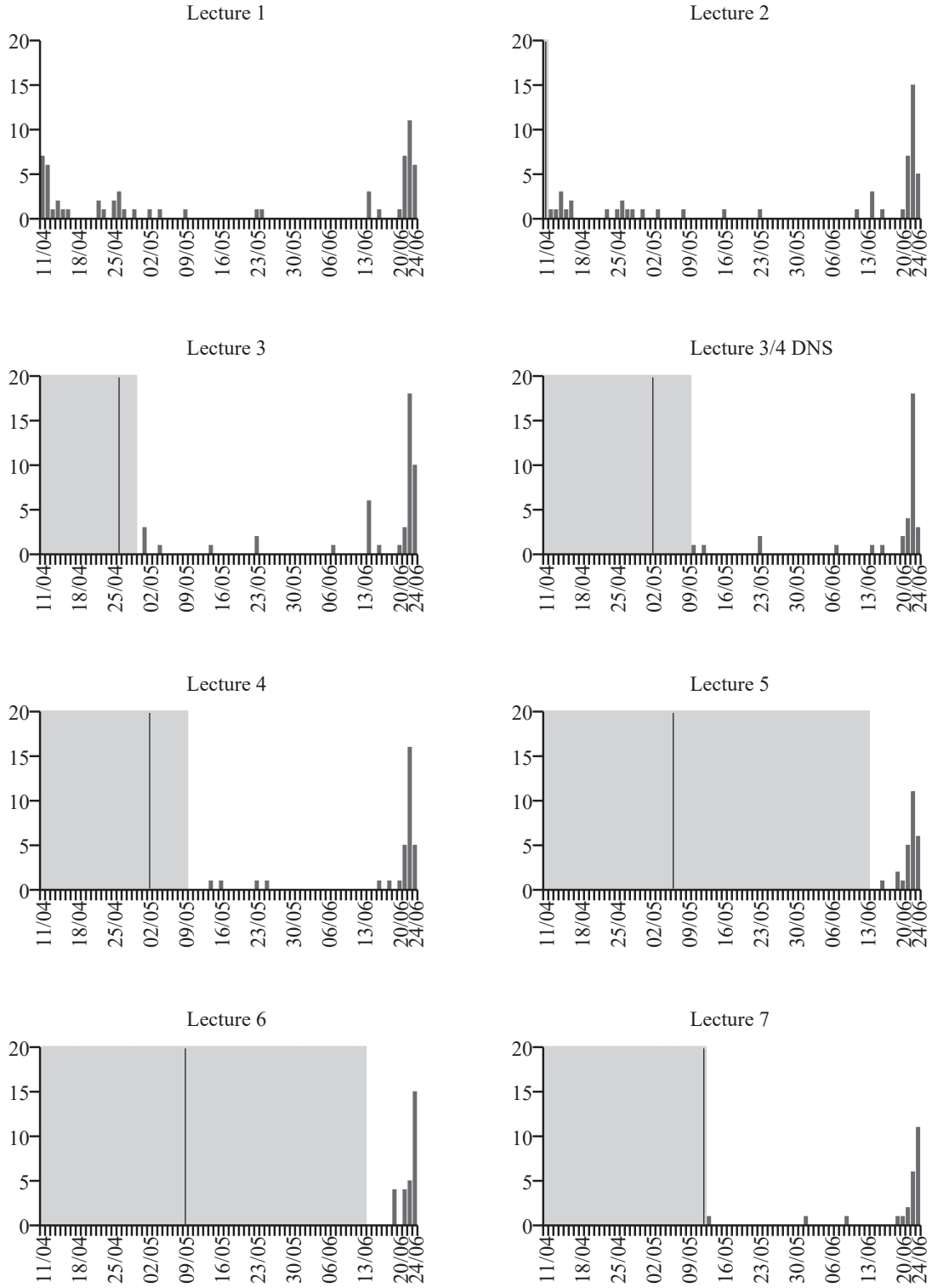

Fig. 2.2. Distribution of quizzes taken per day.

Quiz name	Students
Lecture 1	51
First week	18
Last week	20
Lecture 2	39
First week	8
Last week	20
Lecture 3	30
First week	3
Last week	21
Lecture 3/4 DNS	27
First week	2
Last week	21

Quiz name	Students
Lecture 4	28
First week	2
Last week	23
Lecture 5	26
First week	4
Last week	24
Lecture 6	23
First week	2
Last week	22
Lecture 7	24
First week	1
Last week	21

Fig. 2.3. Number of students taking each quiz.

2.5 Discussion

Biggs & Tang (2007) provide a short but vicious assessment of multiple choice as a method of assessment. Indeed there are a number of problems with the format, some of which will be addressed in this section. There are however also positive aspects of the multiple choice question format, some of which have already been covered indirectly (such as automatic correction) and others will be alluded to in this section. While Biggs and Tang do not have many sympathetic words to offer multiple choice questions they do finish the section by writing positively about Mazur's use of concept questions in lectures and state that "[multiple choice questions] can be useful as a minor supplement to other forms of assessment and for quick quizzes".

The way they multiple choice questions are being used in the Datanet course is exactly that, as a minor supplement and is it is not used as a form of assessment at all. The fact that the quiz is voluntary and the result of the quiz does not count towards the final grade may well alleviate the problem of trying to game the quiz in order to achieve a higher score, which Biggs and Tang identify as a common problem. It is unfortunately, in the system used to deliver the quizzes, impossible to avoid a final score being displayed to the student. This could perhaps present a danger that a student will focus overly much on the score rather than on exploring the reasons behind wrong answers or questions they might have been unsure about.

A more pressing problem, given that the quizzes stated purpose is: lecture review and exam revision, is whether students might narrow their focus in revision, to cover only specific areas included in the quiz. Since the quizzes' questions have been made by the lecturer, a student might guess, most probably incorrectly, that the set of questions in the quizzes represent a strong suggestion as to what will be on the actual exam. One way to avoid this problem is to ensure that the questions are aligned to the intended learning outcomes of the course. This is one area where the quizzes used in the Datanet course could probably be improved, as they are perhaps currently aligned more towards the contents of the lectures as opposed to the intended learning outcomes of the course. This leads to the quizzes covering a large number of specific subtopics related to the lecture.

A student might also think that doing the quizzes is of no value since it is not likely that the questions in the quiz will be on the exam (they are, after all, already public!) This might again be alleviated by proper alignment of the quiz. A related problem is that the format of the quiz (multiple choice, marked automatically) and the format of the exam (short answers, marked by one of several teachers) are quite different. This discrepancy may lead to questioning of the usefulness of the quizzes since it can be hard to see a link between these two assessment methods. However this would be a misunderstanding of the intent of the quizzes that can hopefully be addressed by good communication, i.e., ensuring that students know that the quizzes are a tool to inform and self-asses, not a roadmap to the exam.

When using quizzes for formative assessment they should ideally not just show the student whether they answered the question correctly or incorrectly but should also provide formative feedback on why the question is correct or incorrect. Providing feedback for each question or incorrect answer would significantly increase the effort required to write the quizzes, but the effort is probably justified in making the quizzes a resource in themselves. 2003 generally argue positively for the use of multiple choice quizzes in education (specifically law) but put special weight on the importance of providing good feedback when using multiple choice in formative assessment. The author has not been able to find a satisfactory way of making the current online teaching system provide formative feedback. While it seems possible to add formative feedback, the feedback does not seem to feature prominently enough for it to be worthwhile spending time on.

Creating good formative feedback for the multiple choice questions is just one part of what makes a good multiple choice quiz. The questions themselves should be relevant to the students and aligned with the intended

learning outcomes. Best practices in creating questions and answers should also be investigated and employed. There are numerous, easily accessible, resources on the Internet that provide guidance on how to write effective multiple choice quizzes. It is also important to look at the results of the quizzes, both to guide the teaching itself but also improve the quizzes themselves. Unfortunately the online teaching system used does not provide raw access to students answers, offering instead only some rather unhelpfully presented aggregate data.

In order to use the results of the quizzes to inform teaching, it is important to ensure that students use the quizzes closer to the lecture, rather than just for exam review. One strategy employed by Leon (2002), is refocusing quizzes such that students are more likely to take them, for example as a mandatory preparation for the weekly exercise classes. This would enable the quizzes to directly influence the focus of the topics covered in an exercise class in order to address problem hot-spots identified by he quiz.

2.6 Conclusions

Perhaps by addressing some of the points discussed above the quizzes could become an effective way of making students re-engage with lecture material. However, given the data presented in this paper it is not possible to conclude whether online lecture review quizzes are an effective way of making students re-engage with the lecture material. It is possible to say that for the 2010/2011 Datanet course the lecture review quizzes were *not* successful in getting students to re-engage with the lecture material. It was instead used by a significant portion of the students in the days leading up to the exam. Whether it was successful as an aid in studying for the exam is also not clear from the data due to the small number of course evaluation responses.

Instead of providing a conclusive answer to the above question, the paper has identified a number of problems that can be addressed in a future course's use of the quizzes as well as suggestions for improvements based on relevant literature. Should the quizzes be used in a future course the author would be in a much better position to gather interesting data that might help answer the posed question as well as pose new and more interesting questions.

However, if engagement with the material in order to promote knowledge retention is the goal, it is perhaps important to look at alternative

approaches, or at least not rely solely on the lecture review quizzes. While the quizzes may be able provide a useful resource to some students, the effort in making them may outweigh their benefits. Using or supplementing with other methods, such as Mazur's concept questions (Mazur 2009) or the inquiry-based approach taken by King (1992) which also promotes better knowledge retention (King 1995), may ultimately be more beneficial for the students.

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/2011-4/

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