Providing Fine-grained Feedback Within an On-line Learning System – Identifying the Workers from the Lurkers and the Shirkers

Colin Egan, Amanda Jefferies and Jason Johal
School of Computer Science, University of Hertfordshire, U.K
c.egan@herts.ac.uk
a.l.jefferies@herts.ac.uk

Abstract: This paper describes a mechanism developed by the authors to gather student feedback from formative revision Multiple Choice Questionnaires (MCQs) within an on-line learning system. The MCQs provided first year Computer Science students with instant formative feedback, while data was also gathered about student responses, such as the percentage opting for each answer and the time taken to answer the question. We measured how students were using our on-line learning system; whether they were in fact 'workers' who provided answers to the MCQs, were 'lurkers' who did not provide answers but asked for solutions or 'shirkers', who did not access the site at all!

The data indicates that the time taken to answer a harder question was less than that of an easier question suggesting that the workers turned into lurkers strategically when they thought they could not answer successfully. It was not however clear whether the lurker suddenly finding an easier question would change back into a worker. Future work to encourage the shirkers to participate is also discussed.

Keywords: VLE, Formative MCQs, Summative MCQs, On-line teaching, On-line learning

1. Introduction

The emergence of Virtual Learning Environments (VLE) in Higher Education has led to many improvements in student learning experiences as identified by Britain and Liber, (1999) amongst others. However, there are pitfalls in using VLEs and their effect on student learning has been taken up elsewhere. (e.g.Stiles, 2000). One major pitfall of VLEs in the authors' opinion is that of monitoring student access to on-line teaching material. In the class-room environment tutors frequently monitor student attendance by taking registers. This means that non-student attendance at classes is recorded. Even though most if not all VLEs require authentication, by use of a username and password, to access on-line teaching material, monitoring student access to on-line material is not a simple task. For example, here at the University of Hertfordshire we can monitor the number of student logins, but as lecturers we cannot yet identify who is logging in and using our VLE. This means we have an overall idea of the proportion of our VLE users to the proportion of non-VLE users. In this paper, we classify those students that do not login to our VLE as 'the shirkers'.

Many VLEs provide tutors with the option of providing students with formative multiple-choice-questionnaires (MCQs) or tasks to undertake and it is common for tutors to provide solutions to such MCQs. Clarke et al (2004) discuss the pedagogical use of MCQs for formative testing in detail. However, this feedback is one-way, from the tutor to the student which we call the tutor $\rightarrow$ student feedback, since there is no facility for feedback from the student to the tutor.

This has led us to identify a number of problems which we attempt to address in this paper. Namely these problems are: How does the tutor know the proportion of students who are actually undertaking the formative exercises? How does the tutor know if a student is just looking at the solutions and not doing the formative exercises? How does a tutor know how long a student is spending on each formative exercise?

In the class-room, the environment is under the control of the tutor and the tutor gathers feedback from students from a number of sources that help to address these problems, which we call the student $\rightarrow$ tutor feedback. The tutor can observe, talk and time students as they tackle set exercises and the tutor can adapt and amend his/her teaching approach accordingly. This type of dynamic teaching control is not usually available through a VLE.

We have refined our on-line learning system to address the three questions we have posed and attempt to provide the tutor with the control that he/she has in the class-room. The idea behind our learning system is to monitor in the back-ground what students are doing when they access our formative MCQs or tasks on the University's VLE. Currently we are monitoring anonymously, that is we do not monitor a username and we cannot

Reference this paper as:
Egan Colin et al (2006) "Providing Fine-grained Feedback Within an On-line Learning System – Identifying the Workers from the Lurkers and the Shirkers" *The Electronic Journal of e-Learning* Volume 4 Issue 1, pp 15-24, available online at www.ejel.org

therefore identify individual students. Our approach is that when a student opens a web-page to try one of our MCQs or one of our tasks then a timer is started and statistics gathered. Every MCQ or task requires some form of an interactive answer and this response is captured by our learning system. When the student submits a response or instead requests the solution to the MCQ or task the timer is stopped. In both cases, we provide the student with our solution to the MCQ or task (the tutor $\rightarrow$ student feedback). From this simple information, we gathered a number of statistics. The statistics are broken down into two types: the 'lurkers' and the 'workers'. The lurkers are those students who view our formative teaching material and do not respond other than to receive the tutor's solution. The workers are those students that answer our formative MCQs. We use these statistics to tell us the proportion of students that are 'shirkers', 'workers' or 'lurkers'.

We gather further statistics from the workers to tell us the proportion of students that correctly and incorrectly answer each MCQ or each task. We also gather statistics about the time taken by each student to answer each MCQ or the time taken to undertake each task. We have now achieved the student $\rightarrow$ tutor feedback, which we can act on. For example, if the number of students answering an MCQ incorrectly is higher than we expect or it takes the average student a longer time to answer the MCQ than we expected then we have identified an area that students are struggling to understand and we can further adapt our VLE teaching material to address the problem that has been highlighted through the student $\rightarrow$ tutor feedback.

The layout of the rest of this paper is as follows. In Section 2, we briefly describe the functionality of our VLE, known as StudyNet. In Section 3, we describe our experiences of teaching Computer Science on a VLE. In Section 4, we discuss our on-line learning system and evaluate our feedback results. Finally in Section 5, we provide conclusions and a discussion.

2. StudyNet

The University of Hertfordshire firmly believes that the use of VLEs in learning and teaching is an important tool for both students and staff. This led to the university becoming one of the first UK universities to use a campus-wide VLE with on-line access to modules for all students and staff through its own in-house VLE called StudyNet (Jefferies et al, 2004).

StudyNet enables students and staff to access information through a web-browser both on- and off-campus. This means that all students and staff have access from a computer system on campus or over the internet to their own customised web-space. From the student perspective, this links students to module descriptions, lecture notes, university and module news items, on-line discussions, and group discussions, assessments, the university's library system, the university's e-mail system, the Students Union, the Careers Service and other information resources. StudyNet has therefore become the main source of information between students, academics and the university itself (Thornton et al, 2005).

In a recent report McNab (2003) states that from a potential number of StudyNet users of over 21,000 almost 16,000 (72%) of users login and use StudyNet. This means, from the perspective of our VLE, that 72% of our students are workers or lurkers and only 28% of our students are shirkers. In particular, in our Faculty of Engineering and Information Sciences the number of StudyNet users were reported by Macnab to be over 3,700, which is about 90% workers/lurkers and 10% shirkers. Surprisingly, the Faculty of Engineering and Information Sciences was not the highest proportion of users; this was achieved by the Faculty of Law where there are over 1,000 users, which is about 96% workers/lurkers and only 4% shirkers. Perhaps not so surprisingly, the Faculty of Art and Design achieved the lowest proportion of users with over 750 users, which is about 59% workers/lurkers and 41% shirkers. This StudyNet usage range of 59% to 96% of workers/lurkers is extremely encouraging and is indicative of the emphasis that the University of Hertfordshire has placed on the accessibility of on-line learning through StudyNet

3. Student use of on-line revision MCQs

In this study we targeted our MCQs towards first year undergraduate Computer Science students. We chose first year students for two main reasons. First, because we considered that first year students are more likely to be receptive to using our VLE and we wished to capture a true reflection of the ratio of workers, lurkers and shirkers. Second, at least two of our first year taught modules use MCQs as summative assessment to compose student grades.

3.1 Study 1

In our first study, we decided to invite our students to undertake 50 formative revision MCQs *'which might help them with their revision for their end of year exams'* (ie. an optional aid to help with their revision) in the summer of 2004. We wrote our

MCQs for a double module course called Computer Systems and Networks. The major aims of Computer Systems and Networks are to enable students to appreciate the features of a selection of general purpose computers, computer peripherals and network technologies. The module also aims to enable the students to acquire the technical basis to understand semi-technical evaluations of computer systems and to interpret manufacturers' publicity about their systems. The final aim of the module is for students to appreciate how hardware and software support High Level Languages. Computer Systems and Networks is therefore a highly technical subject and has a reputation among students for being a difficult subject, which thus rendered it ideal for our trial!

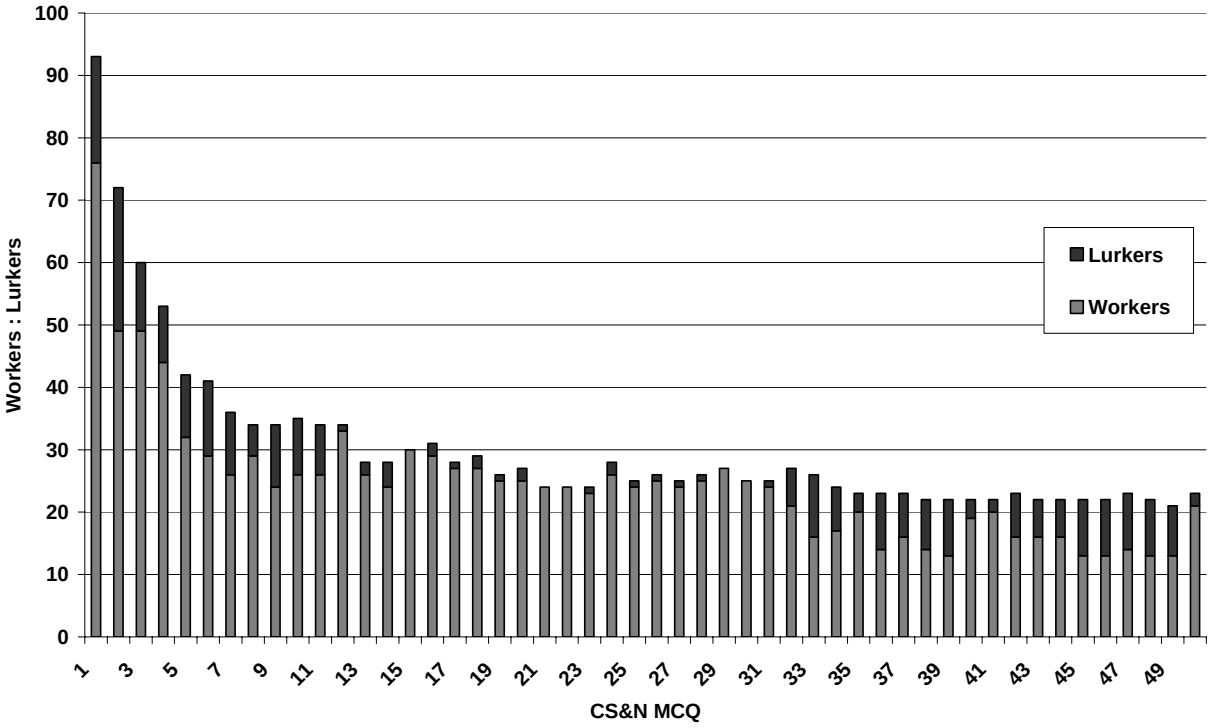

Figure 1: The proportion of workers:lurkers per Computer Systems and Networks (CS&N) MCQ.

In this initial study, we made the revision MCQs available to a cohort of 214 students. Figure 1 shows the ratio of workers: lurkers for each of our 50 revision MCQs. There were 93 students who initially logged onto our revision on-line learning system, approximately 43% of those who could have logged on. Only 21 (approximately 10%) of the students looked at all 50 MCQs. This means that there were 121 (approximately 57%) shirkers who did not use our revision on-line learning system at all; this deteriorated to approximately 90% by the end of the revision MCQs. Of the 93 students who looked at the first MCQ, 76 (approximately 83%) were workers and 17 (approximately 17%) were lurkers. By the time the students had experienced 7 MCQs the number of workers/lurkers tailed off to about 35 (approximately 16%) students, which continued to decline to 24 (11%). The number of workers/lurkers remained around 24 for the rest of the 50 MCQs.

Unknown to our students we ranked each MCQ into one of three categories easy, moderate or hard. We considered 25 MCQs to be easy, 16 MCQs to be moderate and 9 MCQs to be hard. We also estimated that over 60% of all of our students would be able to successfully answer an easy MCQ within 60 seconds. We estimated that about 50% of our students would be able to answer a moderate MCQ successfully in under 120 seconds. Finally we estimated that less than 50% of our students would be able to answer a hard MCQ successfully in less than 180 seconds.

Overall the percentage of worker students answering MCQs correctly was in the range 41% to 92%. Figure 2 shows the percentage of workers answering each of our three categories of MCQs successfully. Our estimation for the proportion of workers successfully answering each category of MCQs correlated well with the actual percentages from the workers' responses. Approximately 67% of the workers successfully answered the easy MCQs, approximately 53% of the workers

successfully answered the moderate MCQs and approximately 32% of the workers successfully answered the hard MCQs.

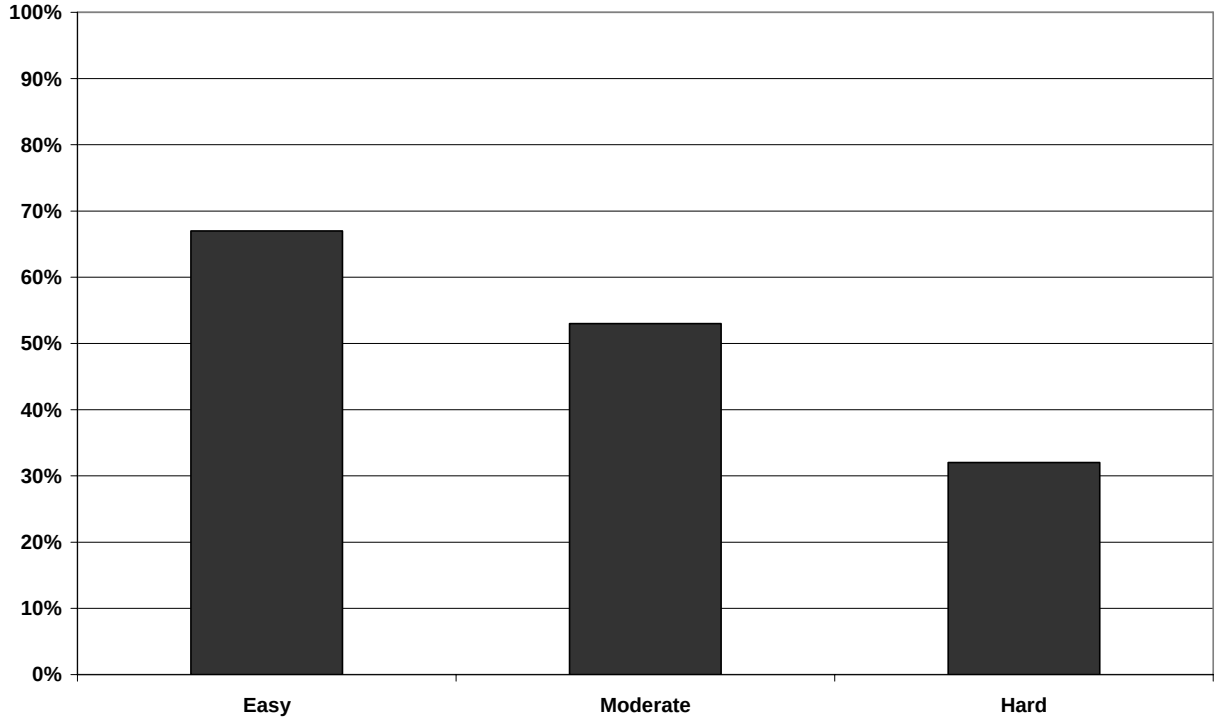

Figure 2: The percentage of students correctly answering each category of MCQs.

However, our estimates for the amount of time proved to be incorrect, as shown in Figure 3. We expected the student response times to be far greater than they actually were. For example, we expected a worker to successfully respond to an easy MCQ within 60 seconds; the successful response time for an easy MCQ turned out to be within 45 seconds. It is clear that some of the lurkers considered responding because the lurker time was within 53 seconds. For the moderate MCQs, the worker's successful response time was less than that of the easy MCQ response time and was within 39 seconds. The lurker response time was within 50 seconds. Finally, the successful worker response time was within 29 seconds for the hard MCQs and the lurker response time was within 42 seconds.

Our results suggest that students appraise MCQs quickly, if they consider that they can answer the MCQ they respond, if they consider that they cannot answer the MCQ they may think about it for a short period of time and then request the answer. We also consider that students form a decision quickly and if they consider the MCQ to be too difficult for them to answer they either guess an answer or request the answer and become a lurker for that MCQ.

For five MCQs there were no lurkers. Intuitively, we thought these would be easy MCQs which were answered quickly and correctly by all students. This turned out to be a false premise. We had categorised three of the five MCQs as easy and the other two as moderate. Furthermore, the range of correct responses was 40 – 75% and the response time was 16 – 43 seconds.

We identified a small number of MCQs that caused students some problems. This was because: few students answered an MCQ correctly, the time taken to respond to answer an MCQ was either greater than or less than our expected time. In the case where the time was less than our expected time and the proportion of students answering the MCQ correctly was high then this meant that the MCQ was probably not sufficiently challenging. In the case where the student response time was far less than our expectation and the proportion of students answering the MCQ correctly was low, then this MCQ was either too challenging for the students or we may have taught the material not as clearly as we should.

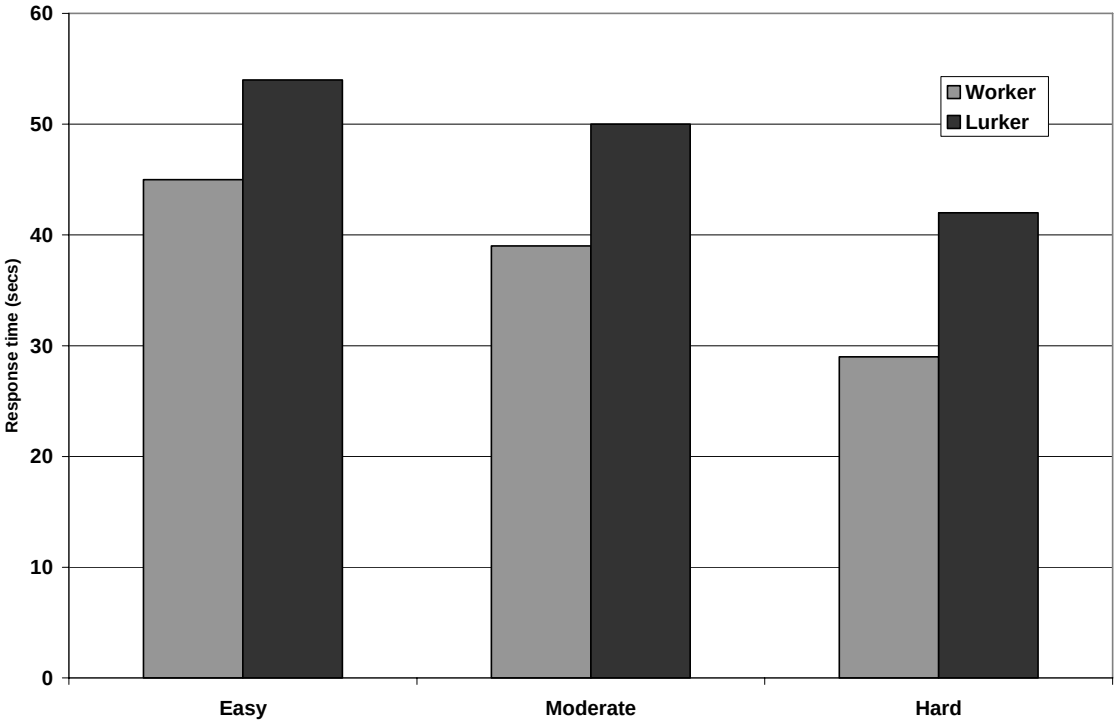

Figure 3: Worker/lurker response time for each category of MCQ.

3.2 Study 2

We decided to re-evaluate our results in a second study. This second study was offered to a new cohort of students in the first semester of this academic year (2004/2005). Again, we invited first year Computer Science undergraduates for the same double module course, Computer Systems and Networks, to participate and we also included MCQs from a second double module course entitled Formal Systems.

The aims of the Formal Systems module is to enable students to develop confidence in formal and mathematical modes of discourse, to experience a range of formalisms that are useful in the design of programmed systems and for the students to appreciate the relationships between mathematics, formal (symbolic) reasoning and programmed systems. Similarly to Computer Systems and Networks this course has a student reputation for being a difficult subject, which renders it ideal for our study.

In our second study, we provided 10 formative revision MCQs for Computer Systems and Networks and a further 10 formative MCQs for Formal Systems which, as in the first study, might help the students with their revision for their (in this case) mid-semester summative assessments. There were a number of key differences between this study and the first study. First, we could not offer the same cohort of students MCQs because they would now be in their second year of study. In the second year of study, MCQs are not generally used to assess our undergraduate students. Instead our second year students undertake a number of courseworks assigned at different times throughout the academic year, followed by traditional written exams at the end of the second semester. Therefore, this type of study would provide little benefit to these students. Consequently, we decided to continue our study with first year undergraduates, even though it meant it was a different cohort. The second major difference was that we offered the formative MCQs from two different courses. Third, we reduced the number of MCQs to 10 for each course and fourth, the MCQs were provided as 2 banks of 5 MCQs for each course. We deliberately reduced the number of MCQs because of the rapid reduction in those attempting the MCQs in the first study and because this new cohort of students had only studied for a short period of time. We provided the MCQs as two banks of 5 because we considered students would be more likely to complete the MCQs if they were in short sequences which they could undertake all at once or even by attempting the MCQs on two different occasions. We offered two different courses to investigate if there would be different responses to different courses. A total of 155 students undertook the mid-semester summative tests.

In study 2, Figure 4 reflects Figure 1 of study 1, except in this study there were only 20 MCQs which were divided into two banks of 5 MCQs for Computer Systems and Networks and a further two banks of 5 MCQs for Formal Systems. More students attempted the Formal Systems MCQs than the Computer Systems and Networks MCQs. We attribute this to one major difference; in both cases the students were e-mailed to inform them of the revision MCQs, however the Formal Systems tutors, also, verbally informed their students about the revision MCQs during class contact time, whereas the Computer Systems and Network tutors did not.

Initially 55 students logged onto the first bank of Computer Systems and Network revision MCQs, approximately 36% of those who took the summative MCQ a short while later. By the end of the first bank of MCQs this number had reduced to 36 (approximately 23% of those that took the summative MCQ). 39 (approximately 25% of those that took the summative MCQ) students logged onto the second bank of Computer Systems and Networks MCQs which declined to 26 (approximately 17% of those that took the summative MCQ) by the end of the second bank of MCQs. The number of logons for the Formal Systems MCQs was more encouraging; 138 (approximately 89% of those that took the summative MCQ) of the students initially logged onto the first bank of MCQs. This declined to 83 (approximately 53% of those that took the summative MCQ) by the end of the first bank of Formal Systems MCQs and 78 (approximately 50% of those that took the summative MCQ) of the students logged onto the second bank of Formal Systems MCQs, which declined to 58 (approximately 37% of those that took the summative MCQ) by the end of the second bank of MCQs.

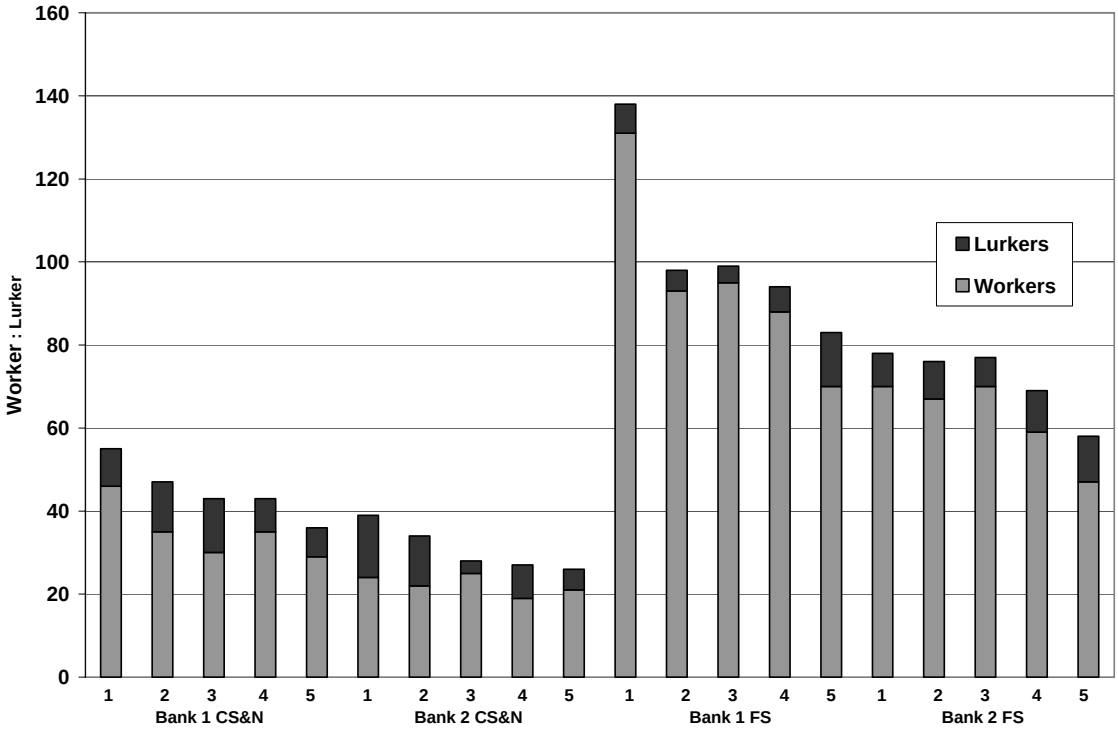

Figure 4: The proportion of workers:lurkers per Computer Systems and Networks (CS&N) MCQ, and per Formal Systems (FS) MCQ.

Of the 55 students who initially logged onto the first bank of Computer Systems and Network MCQs, approximately 84% were workers and only approximately 16% lurkers. By the end of the first bank of MCQs the proportion of workers remained relatively high at approximately 80% and this was mirrored with the second bank of MCQs. Similarly, of the 138 students who initially logged onto the first bank of Formal Systems MCQs, approximately 95% were workers and only approximately 5% were lurkers, which declined to about approximately 85% of workers at the end of the first bank of Formal Systems MCQs. Again, this was mirrored in the second bank of Formal Systems MCQs.

As with Study 1, in this second study we ranked our MCQs into the same categories (easy, moderate and hard). We also applied the same time estimation to each category (an easy MCQ

should be answered successfully by 60% of our students successfully within 60 seconds, a moderate MCQ should be answered successfully by 50% of our students within 120 seconds and a hard MCQ should be answered successfully by 50% of our students within 180 seconds), we applied these metrics to both Computer Systems and Networks, and Formal Systems. We categorised 4 of the Computer Systems and Networks MCQs as easy, 4 as moderate and 2 as hard, similarly we categorised 3 Formal Systems MCQs as easy, 4 as moderate and 3 as hard.

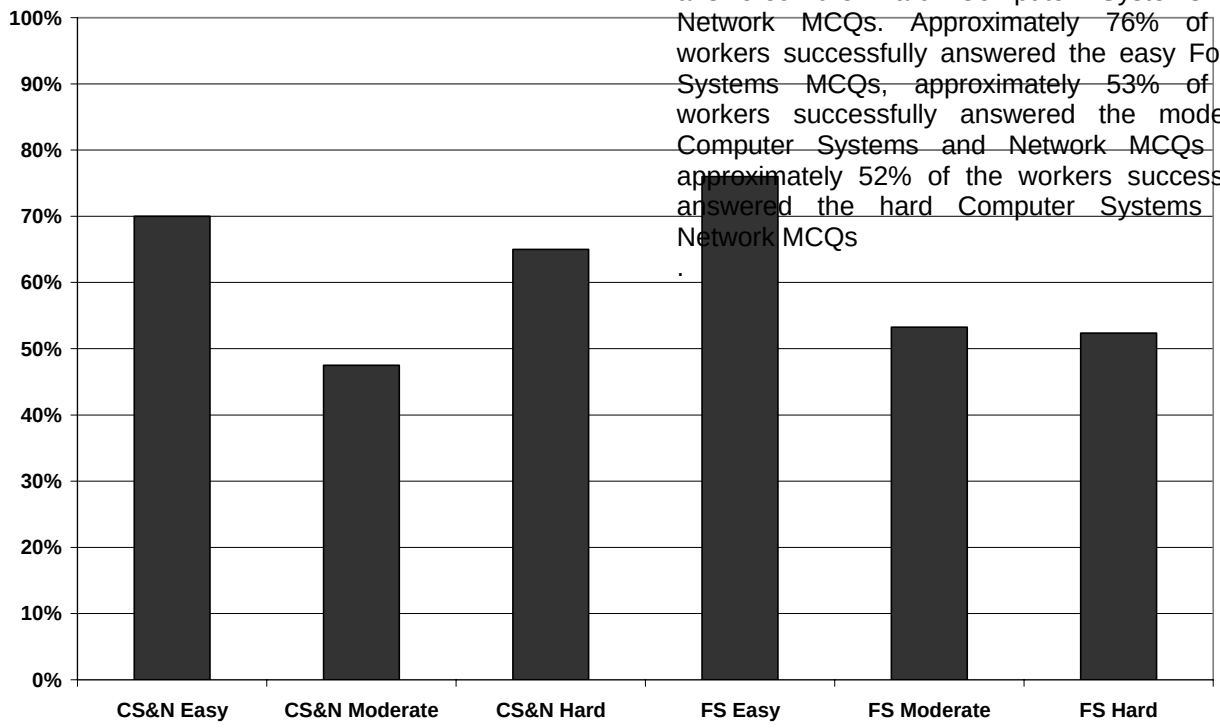

Figure **5** shows the percentage of workers answering each of our three categories of MCQs successfully for both courses. Again, our estimation for the proportion of workers successfully answering each category of MCQs correlated reasonably well with the actual percentages from the workers' responses. Approximately 70% of the workers successfully answered the easy Computer Systems and Network MCQs, approximately 48% of the workers successfully answered the moderate Computer Systems and Network MCQs and approximately 65% of the workers successfully answered the hard Computer Systems and Network MCQs. Approximately 76% of the workers successfully answered the easy Formal Systems MCQs, approximately 53% of the workers successfully answered the moderate Computer Systems and Network MCQs and approximately 52% of the workers successfully answered the hard Computer Systems and Network MCQs
.

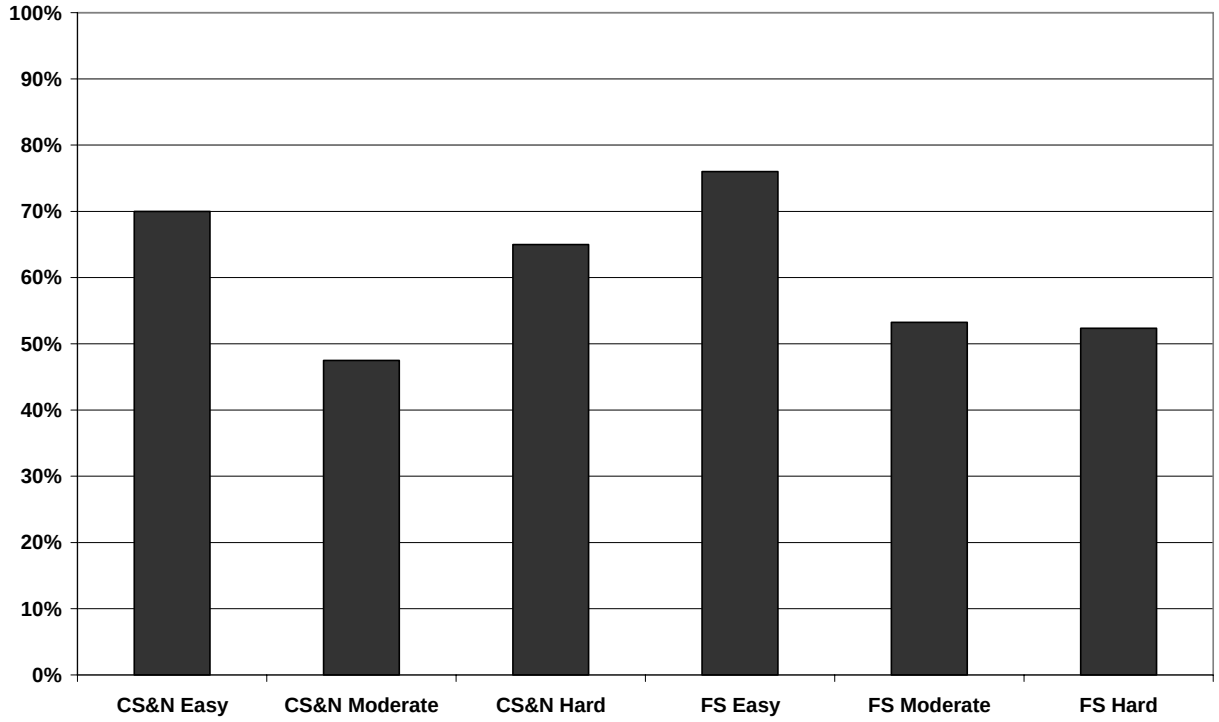

Figure 5: The percentage of students correctly answering each category of MCQs

In study 1, our estimates for the amount of time proved to be incorrect and we changed our Computer Systems and Network MCQs in study 2 to suit our time estimations. We decided to change the MCQs rather than our time estimations, because in summative assessment students have a strict time limit and therefore we did not want to increase or decrease student response time. In study 2, the student response time for those students who correctly answered our Computer Systems and Networks easy questions was within 114 seconds, approximately double our time estimation, as shown in

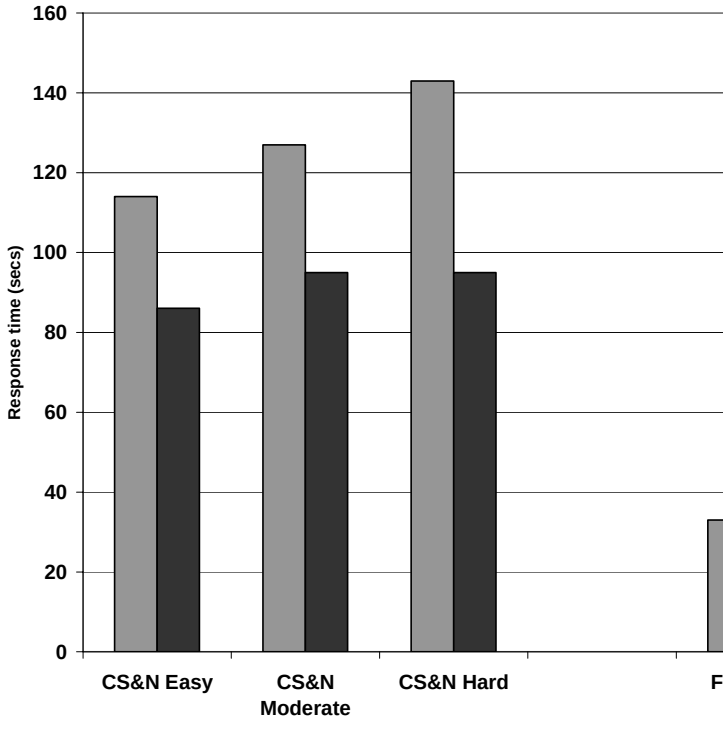

Figure **6:** Worker/lurker response time for each category of MCQ for Computer Systems and Networks (CS&N) and Formal Systems (FS).

. However, our time estimations for the moderate and hard MCQs closely mapped to the student response times (within 127 seconds for the moderate MCQs and within 143 seconds for the

hard MCQs). The successful response time estimations for the Formal Systems MCQs proved to be far greater than the actual student response time, the easy Formal Systems MCQs were correctly answered within 33 seconds, the moderate MCQs within 81 seconds and the hard MCQs within 59 seconds. These results verify our premise from study 1 that students appraise MCQs quickly and respond by either submitting an answer or requesting the solution.

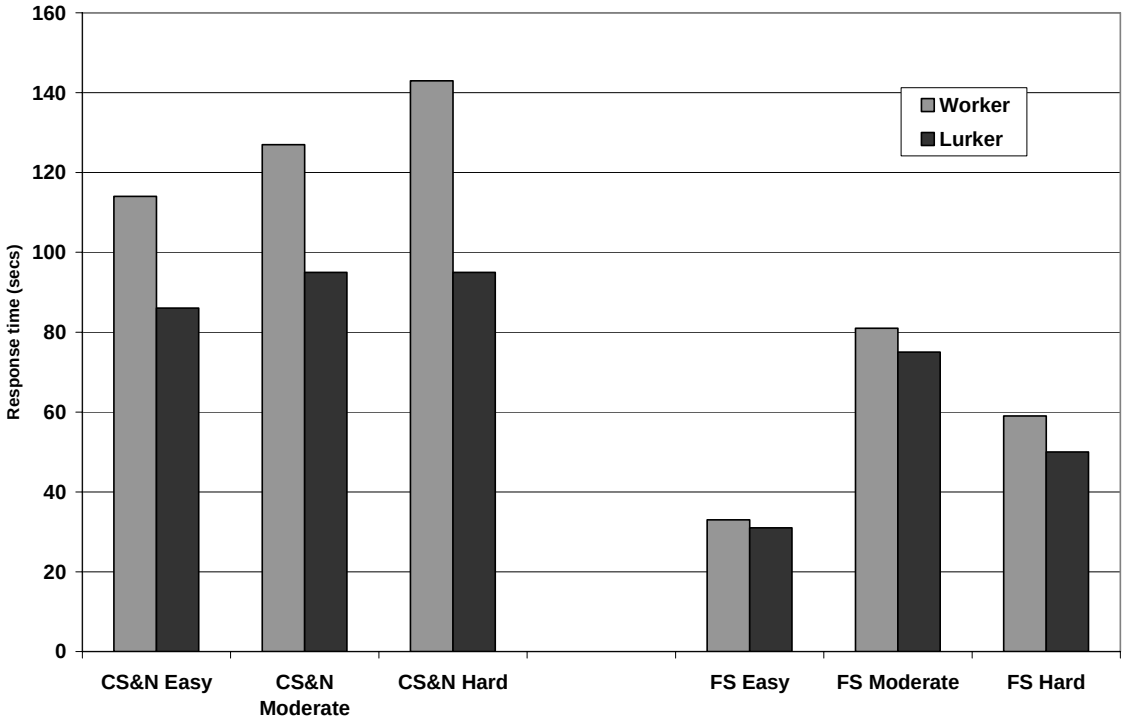

Figure 6: Worker/lurker response time for each category of MCQ for Computer Systems and Networks (CS&N) and Formal Systems (FS).

4. Conclusions and discussion of future work

Our results have helped us to answer the three questions that we were attempting to answer.
How does the tutor know the proportion of students who are actually undertaking the formative exercises?
How does the tutor know if a student is just looking at the solutions and not doing the formative exercises?
How does a tutor know how long a student is spending on each formative exercise?

Using our on-line learning system we can estimate the maximum number of students attempting the formative MCQs. It was interesting to note that more of the Formal Systems students engaged in our on-line learning system than the Computer Systems students, yet they were from the same cohort studying the same subjects. The Formal Systems tutors verbally encouraged their students to attempt our on-line revision MCQs. This indicates that on-line learning is not a substitute for student/tutor contact but should be used in a blended manner to augment each teaching strategy and to improve the student learning experience.

Using our on-line learning system, we can now suggest a classification of students into three categories: workers, lurkers and shirkers. We are disappointed with the high number of shirkers and are now actively considering ways to encourage more students to engage in such blended teaching/learning systems.

We can now estimate the amount of time students spend on formative questions. In our case, this helped us to change our expectations between the first and second study. Since students are often placed under time constraints during summative assessments, we consider that we as academics must provide the students with a fair and reasonable amount of time to answer our summative questions. Our on-line learning system is providing us with good indicators of how this might be achieved and is making us re-evaluate our question timing schedules. Classifying questions into different categories is helpful

because we can associate each category with a different time metric. It is also in line with similar studies on using MCQs effectively such as the work undertaken at University of Leicester and the guidelines of the University of Cape Town(University of Leicester, 2005)

We would like to identify which student is using our on-line learning system and when they are using it. Currently at the University of Hertfordshire StudyNet does not provide us with the ability to identify individual students. When we are able to identify individual students, we plan to correlate the use of our on-line learning system with class attendance and to compare results of summative assessments from results obtained from of our formative assessments.

From this proposed new study we would be able to identify in more detail how students engage with their studies. First, we would be able to quantify the number of occasions and the amount of time each student engages with our formative MCQs. Currently, we cannot quantify usage in an absolute manner. We consider that it would be beneficial for us as academics to be able to correlate the student usage frequency and student frequency usage time that is spent on formative MCQs. We could then use this information to identify areas of student concern with the taught material, and then we could dynamically amend our teaching material to improve the student learning experience. Second, we would be able to compare both individual student and cohort summative assessment results with on-line MCQ formative assessment results. One consideration is to repeat a previously used summative MCQ assessment as a formative MCQ assessment but to a different cohort of students. We could then estimate with a higher degree of accuracy the actual amount of time a student spends on each MCQ without the additional pressure of a timed summative assessment. This would also help us to estimate the number of MCQs that students 'guess' the answer to in a summative assessment, since in our own model a student can request the solution to a formative MCQ. In contrast in a summative MCQ assessment a student who does not know the answer would probably 'guess' the answer (so long as there is no negative marking employed) or simply ignore that question. Information extracted from this would help us to write our MCQs (both summative and formative). Third, the second concept leads to the idea of a building a bank of MCQs as described by inter alia Liechti at University of Paisley (Liechti,2005). We could use this bank of MCQs to provide us with formative and summative questions to monitor and compare different student cohort responses over a number of years. In this case, we would recommend refreshing the MCQ bank regularly by the insertion of new MCQs and the removal of aged (used repeatedly) or stale (out-of-date, perhaps due to technological subject enhancements) MCQs. We suggest that new MCQS should initially be used as formative questions, which would then help us to identify and correlate whether our questions realistically fall into the categories of hard, moderate or easy. Therefore when an MCQ is used (or amended for use) as a summative MCQ we would have removed any potential timing error of incorrect categorisation. Fourth, we would be able to identify whether non-attending students are in fact engaging with on-line material provided and are at less of a risk of failing than supposed..

In summary, this is on-going work and we have answered some questions but have posed many more, There is a great deal of scope in the authors' opinion for further development in this area of providing fine-grained feedback within on-line learning systems to support and improve the students' overall learning experience.

References

Britain, S & Liber, O, (1999), "A framework for pedagogical evaluation of virtual learning environments". *A report presented to the Joint Information Systems Committee's Technology Applications Programme (JTAP).* http://www.leeds.ac.uk/educol/documents/00001237.htm

Clarke,S, Lindsay, L. McKenna, C., New, S.(2004) *INQUIRE a case study in evaluating the potential of on-line MCQ tests in a discursive subject*, ALT-J, Research in Learning Technology Vol 12, No 3 pp250-260

Jefferies,, A., Thornton, M. Alltree, J, Jones, I. *Evaluating the benefits of Web-Based Learning with Academic Staff,* Proceedings of the WBE-2004 IASTED International Conference on Web-Based Education (ACTA Press,2004;ISBN:0-88986-406-3)

Liechti LEAP Case Study 16: Apr 2005*Case study on continuous assessment using Blackboard at University of Paisley* : www.heacademy.ac.uk/resources.asp?process=full_record&section=generic&id=575 accessed December 12, 2005

McNab, C. (2003) *Measuring StudyNet Use*, LTDU Magazine, University of Hertfordshire, U.K.

Stiles, M.J.,(2000) *Effective Learning and the Virtual Environment Proceedings: EUNIS 2000 - Towards Virtual Universities*, Instytut Informatyki Politechniki Poznanskiej, Poznan April 2000, ISBN 83 913639 1 0

Thornton, M. Jones, I, Jefferies, A. Alltree, J. Doolan, M.& Parkhurst, S. (2005) *Proceedings of the Third Hawaii International Conference on Education*, Honolulu, January 3-6. Using a Managed Learning Environment in Higher Education: the students' views.

University of Leicester CASTLE project quoting the work done at the University of Cape Town in South Africa at: http://www.le.ac.uk/castle/resources/mcqman/mcqchp4.html#4.6 accessed on December 12 2005

