Impact on student learning: Student evaluations of online formative assessment in fluid mechanics

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This paper looks at the way in which students in core second and third year units of study are using a set of automated practice calculations which have been developed with automatic marking and feedback, and prepared and delivered online. The calculations are in spreadsheet format and are downloaded by students from a *WebCT* site. Every time students open a file they are presented with a new set of data to practice on. These calculations were introduced into a 2nd year unit in semester 2 2005 and a 3rd year unit in semester 1 2006. The students' use and perceptions of use in general were correlated with student performance on complex calculations questions in the final examination. The results of this analysis will: a) improve the student learning experience in relation to the way in which the online resource is being used to complement face-to-face teaching; b) develop a model for the provision of online automated practice activities to be made more widely available throughout the School of Civil Engineering and the wider University.

Background

Second and third year fluids engineering students experience difficulty developing fundamental knowledge and skills before entering their senior years. This is particularly evident in units of study where complex technical calculations are a core component and students need to make appropriate use of a number of concepts to solve problems with many variables under a broad range of circumstances. They also need practice applying formulas to real situations. Traditionally, these students have attended lectures and tutorials, accessed course materials online and obtained paper-based practice materials and answers. However, these practice materials have not included feedback with hints to help students choose appropriate calculations, or to make repeat attempts at solving problems. Additionally, students are unable to easily observe the sensitivity of the output to the input parameters, essential for engineering.

We sought to develop practice activities which would lead students to interact more fully with the learning materials and develop a deeper understanding of the content. The School of Civil Engineering received elearning project support from the University initiative 'USyd eLearning' to develop automated practice activities in 2005 and 2006. These activities became available to second year students in second semester 2005, and third year students in first semester 2006. Discussions are currently underway in the School to apply these activities to other courses with minor modifications and different technical material.

The activities described in Wood and Ward. (2006) enable students to make multiple attempts at each problem. Instant feedback provides increasing levels of assistance at each repeat attempt until the third attempt, when students are directed to the correct answer in the course text. Each question is scaffolded into two or three parts which develop students' basic knowledge, fundamental theory, and skills and knowledge with numerical calculation. This scaffolding follows Biggs' (2003) SOLO taxonomy, as students are required to use an increasing level of understanding as they move from basic to higher order thinking. A range of variables have been used to develop a number of variants of each practice activity - these are randomly generated every time students open the practice activities so students can practise as many times as they wish. The spreadsheets also improve students' generic computer skills in laying out spreadsheets in a logical and structured manner, and involve some of the more advanced features in Excel.

The concept of using Excel extends from the original work conducted by lecturers in the Faculty of Economics and Business, The University of Sydney, who had previously created problems for their

students' summative assessment (Blayney & Freeman, 2004). However, their calculations were relatively simple compared to those in engineering; since summative rather than formative, their code provided higher security to prevent cheating; and automatic downloading and marking modules were developed.

The merit of our research into the students' use and perceptions of use of the complex calculations is to improve the student learning experience in relation to the way in which the online resource is being used to complement face-to-face teaching, and to develop a model for the provision of online automated practice activities to be made more widely available throughout the School and the wider University.

Introduction

The educational research literature shows that students who make use of every learning opportunity approach the final assessment tasks with a greater likelihood of high performance outcomes (for example, Buchanan, 2000; Zarkrzewski & Bull, 1999). Research conducted in the School of Biological Sciences at The University of Sydney has demonstrated that students who use online formative assessment opportunities are more likely to outperform others who do not use them (Peat, Franklin, Devlin, & Charles, 2004). Moreover, Blayney and Freeman (2004) have found that the use of timely and effective feedback in assessment is crucial for learning. However, whilst they have found students want more feedback, increasing class sizes means academics are finding it difficult to find the time to provide it: the second year core unit of study in Civil Engineering has gone from 85 students in 2001 to 190 students in 2006.

This paper looks at the way in which students' use of online automated practice activities with automated feedback may influence the way they learn the content of core second and third year engineering units of study. Our hypothesis is that online practice activities which provide automated feedback and allow students to work at their own pace and at a time which suits them can increase students' learning rate.

Methodology

Seventy-four student evaluations of the online automated practice activities from the second and third year undergraduate units were obtained in semester two 2005 and semester one 2006. The 49 second year responses made up 29% of the student cohort. Of these, 84% were males, the mean age was 20, 100% were enrolled full-time and 92% primarily accessed their online learning materials from home. The 25 third year responses made up 15% of the student cohort. Of these, 92% were males, the mean age was 21, 92% were enrolled full-time and 84% primarily accessed their online materials from home.

Students were surveyed in the final week of semester with a qualitative and quantitative questionnaire which investigated usage of online automated practice activities and the perceptions of the usefulness of these. Completion of the questionnaire was voluntary. In addition to demographic questions, the questionnaire contained: two subscales about the functional and educational aspects of the resource, to which students responded on a 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'; questions assessing how the resource could be improved and overall satisfaction. The WebCT tracking facility was also used to identify a qualitative measure for access to the materials by students and this measure was correlated with the measure of answers to the complex calculations in the final exam.

Results

To assess students' evaluation of the automated practice calculations, analyses were grouped according to the three major sections of the questionnaire. Responses of 'agree' and 'strongly agree' were merged, as were 'disagree' and 'strongly disagree'. Responses on the questions assessing the functional and educational aspects of the automated practice calculations are shown in Tables 1 and 2.

The results show most students had little difficulty using the activities, and either agreed or were non-committal that the 'Read me' file was useful, the resource helped them improve their Excel skills and the resource helped them understand the content of their unit of study. Students were fairly evenly distributed in their evaluation of the usefulness of the feedback and clues. Accordingly, we have redeveloped these in

the updated version of the resource to make them more useful. Responses to the question assessing the overall satisfaction with the online automated practice calculations are shown in Table 3.

Table 1: Survey responses to questions related to functional aspects of the online resource

Survey question	Second year	Third year
Q7: The 'Read me' file helped me to start using the automated practice calculations (APC)	46% Strongly agree/agree* 49% Neutral 5% Disagree/strongly disagree	44% Strongly agree/agree 56% Neutral 0% Disagree/strongly disagree
Q8: I had no technical difficulties downloading the APC file	72% Strongly agree/agree 18% Neutral 10% Disagree/strongly dis.	88% Strongly agree/agree 0% Neutral 12% Disagree/strongly disagree
Q9: I found the APC easy to use	54% Strongly agree/agree 28% Neutral 18% Disagree/strongly dis.	66% Strongly agree/agree 27% Neutral 7% Disagree/strongly disagree
Q10: The APC helped me improve my ability to use Excel spreadsheets	31% Strongly agree/agree 46% Neutral 23% Disagree/strongly dis.	31% Strongly agree/agree 56% Neutral 13% Disagree/strongly disagree

Note. * Likert scale response choices: strongly agree/agree/neutral /disagree/strongly disagree

Table 2: Survey responses to questions related to educational aspects of the online resource

Survey question	Second year	Third year
Q11: The APC helped me understand the principles of fluid mechanics	51% Strongly agree/agree 41% Neutral 8% Disagree/strongly disagree	65% Strongly agree/agree 24% Neutral 11% Disagree/strongly disagree
Q12: The feedback in the APC helped me understand any errors I had made in the calculations	39% Strongly agree/agree 41% Neutral 33% Disagree/strongly dis.	25% Strongly agree/agree 38% Neutral 37% Disagree/strongly disagree
Q13: The clues provided in the APC helped me answer the calculations correctly	36% Strongly agree/agree 56% Neutral 31% Disagree/strongly dis.	44% Strongly agree/agree 25% Neutral 31% Disagree/strongly disagree
Q14: The APC helped me get more out of my fluid mechanics unit of study this semester	44% Strongly agree/agree 41% Neutral 13% Disagree/strongly dis.	29% Strongly agree/agree 59% Neutral 12% Disagree/strongly disagree

Table 3: Survey responses to overall satisfaction with the online resource

Related survey question	Second year	Third year
Q16: All things considered, I would rate the APC as: Excellent, Good, Satisfactory, Poor, Very poor	3% Excellent, 61% Good 32% Satisfactory 4% Poor, 0% Very poor	13% Excellent, 56% Good 25% Satisfactory 6% Poor, 0% Very poor

These positive results demonstrate that the resource is appreciated by students. In the questionnaire students were also asked how the resource could be improved. The largest proportion of responses (39% in second year and 29% in third year) suggested providing more detailed feedback for incorrect as well as correct answers. Other suggestions included making the resource compulsory and awarding marks, with one student writing, "Not enough time… unless the work gets marked I don't do it!!"

The correlation between students' access to the materials and their answers to the complex calculations given in the final exam was identified. Analysis of the second year cohort shows a slight positive trend in the correlation between the number of times students accessed the resource and their results on the final exam. Interestingly, analysis of the third year cohort shows a definite trend, Figure 1, between the results in the final exam and their efficiency in accessing the data; calculated by the number of questions downloaded divided by the total number of downloads. This is statistically significant with an F factor of 15. Results from both years show a slight shift in the number who failed to the number who passed, however, this can not be statistically isolated from other factors, Figure 2.

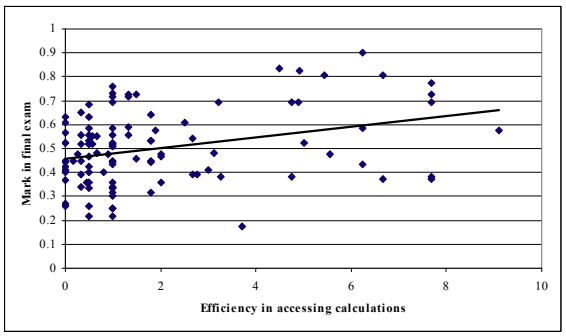

Figure 1: Final exam mark versus attempts

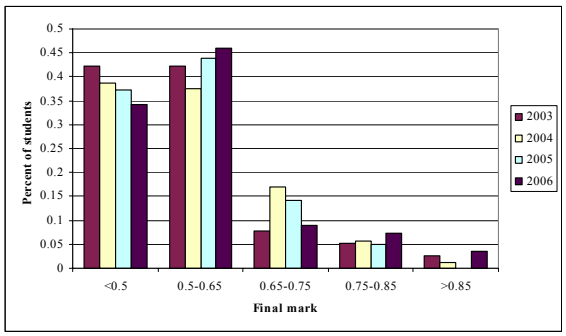

Figure 2: % of students versus overall mark

Conclusion

Initial feedback from students about the online automated practice activities has been positive, with the request for more extensive feedback on incorrect and correct answers. This confirms the findings of Blayney and Freeman (2004) that students appreciate timely and effective feedback in formative assessment. However, we have found the downside of providing more feedback is that students believe they can fully understand a topic from short automated feedback rather than referencing the detailed notes or text. Despite this, more detailed feedback has been incorporated into the VBA code. Also, for this semester it has been made compulsory for students to complete two of the ten activities.

The correlation of usage of the resource and final exam results confirms the findings of Peat, *et al.* (2004) that students who make use of formative assessment resources achieve better results than those who do not. Future evaluations will determine the effectiveness of improvements to the resource and compare the measure of the answers to similar questions between the 2006/7 and 2004/5 student cohorts. Finally, recognition of the usefulness of the resource is contributing to cultural change in The School of Civil Engineering. It has helped inform an analysis of the Bachelor of Engineering curriculum aiming to improve generic computer skills, and will be taken up as a resource across a number of units of study.

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