FOSTERING STUDENT ENGAGEMENT IN UNDERGRADUATE MATHEMATICS LEARNING USING A TEXT-BASED ONLINE TOOL

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ABSTRACT

This paper presents an example of an introduction of text-based online activities in a core unit for non-mathematics science students, which focuses on the development of numeracy skills. The purpose of the online activities was twofold: firstly, they served as an organising device to help students work consistently throughout the semester, and secondly, they provided an opportunity for students to learn from each other. The trial was carried out to address the problem of student disengagement from university life, an emerging trend observed in tertiary institutions which is strongly related to failure and attrition.

The approach of integrating online tasks to on-campus activities is described, and the results of the trial are discussed, including student and staff evaluation. Finally, the paper looks at possible roles that online text-based tasks may take to enrich the educational environment in the context of undergraduate mathematics teaching and learning.

1. Introduction

One of the big challenges academic teachers face today is the decline in student involvement with the university and in their academic performance. An Australian study on trends in the first year undergraduate experience (McInnis, 1995 and McInnis, James and Hartley, 2000) found that students are spending less time on campus and more time in paid employment. The studies suggest that “compared to students who do not work, younger first year students who work part time are more likely to not work with other students on areas of their course, and to study inconsistently throughout the semester” (McInnis, James & Hartley, 2000). Similar trends have also been reported in the US (Astin, 1998 and Kuh, 1998).

Academics are being urged to put forward creative ideas to address this disengagement from university life and apparent lack of commitment, to think of new ways of engaging students that would fit with their lives. Colleges and universities are exploring ways to make students’ experience, particularly in first year, more engaging and successful.

Online environments and communication tools offer unparallel opportunities to enrich the learning experience, to provide students with more flexible programs to fit in with their multiple commitments, to foster student-student and staff-student interaction, and to give students a sense of belonging to a learning community regardless of their physical location. However, approaches using online interaction have not been widely used up until now in the area of undergraduate mathematics teaching and learning. The communication technologies available today such as the internet, e-mail and discussion group facilities present serious challenges for the communication of mathematics; these are primarily text and graphics based and are not ready yet for the easy and user-friendly communication of mathematical symbols.

There are, however, ways to support undergraduate mathematics teaching and learning with text-only based online tools. This paper presents one such approach used in the context of a unit that aims at developing numeracy skills for science students, and suggests approaches that could be applied in mainstream undergraduate mathematics teaching and learning.

2. A case study

The students undertaking the Bachelor of Science at Monash University show the same patterns of disengagement and lack of motivation reported in the Australian study on trends in the first year experience. Over the last years, science has also been an area of high student attrition and failure; according to a recent report, science is one of the areas with lowest completion rates, with less than 60% of Australian science students completing their degree (Martin, Maclachlan & Karmel, 2001).

Here is an account of the approach taken in one of the core first year science units with the aim of addressing the problem of disengagement and improving students’ first year experience. It was first run as a trial in second semester 2001, with the intention to apply the same approach in two other areas of first year science in the academic year 2002. The approach taken was informed by the growing body of literature which suggests that rich learning environments, active student participation, and a strong sense of community can make a positive difference in fostering student success and engagement (Tinto, 1987).

2.1 A core unit for science students not majoring in mathematics

The unit involved in this case study is the first year core unit *The design of science* taken by all science students enrolled in the Bachelor of Science degree course, and who do not have the intention of majoring in mathematics. Students are accepted to the degree with no prerequisites;

the majority of them have not done mainstream mathematics at school. The aim of the unit is the development of generic skills, with an emphasis on numeracy skills such as experimental design, collection and analysis of data, sample surveys, modelling of data and mathematical modelling. The teaching and learning activities revolve around project work carried out in weekly workshops, in which students conduct investigations following the scientific method and write a report including the methods they followed and their conclusions (Varsavsky 2001).

Given the skills-based nature of the unit, it requires from students a continuous engagement with the unit throughout the semester. It also requires students to work on open-ended projects, where students have to decide how they are going to carry out their projects, rather than follow steps given by the instructor. This appears to be the most difficult hurdle to overcome for first year students which, combined with the students' growing isolation within the university system, leads to frustrating learning experiences.

2.2 The use of online activities

In second semester 2001, online tasks were added to the existing teaching and learning activities as an attempt to help students keep their pace and support collaborative learning. The online tasks formed an integral part of the unit activities together with workshops and projects.

The interface used for the online activities was *InterLearn*, a new collaborative web-based learning tool developed at Monash University. *InterLearn* is an online tool designed to support greater interaction between learner and teacher and between learner and learner by facilitating a shared construction of knowledge and understanding. Its first version, developed by Len Webster and David Murphy (Murphy, 2000), was used with postgraduate students and, given its success, the university is now developing *InterLearn* as part of a suite of flexible learning tools for staff to assist them in developing student-centred flexible learning environments.

InterLearn is built on a database structure that allows students' individual text-based responses to online activities to be stored and viewed on demand. Students log on to an individualized worksite where they complete set activities mostly by entering responses into dialogue boxes. The activities can be shared, meaning that they are available for viewing by all course participants, or individual, meaning only the participant and the teaching team can access them. An important feature is that students' responses can be edited, to allow for the development of their tasks after viewing the submissions made by their fellow students, and so facilitate the construction of knowledge and understanding.

The *InterLearn* worksite for *The design of science* was structured around semester weeks. When students logged on to the site, they saw a week-by-week schedule, and below each week, the unit activities that they were required to complete during that week, both in the face-to-face workshop and in their own time.

Some of these weekly activities were online assessable tasks. The tasks were short and focussed, and although each of them had their own objectives, the common aim was to help students to get ready for the workshop or the new project they had to work on. Before the introduction of these online tasks, tutors always had the difficulty of leading a discussion on the topic of the workshop, mainly because students came unprepared, but in many cases also because students found the open ended projects too difficult to handle. At weekly meetings with tutors, the dominant comment was about the "blank student faces" staring back at the tutor expecting directions from him/her rather than coming up with their own suggestions on how to approach the project under discussion. The weekly online tasks had the aim to facilitate the discussion between students in preparation for the forthcoming workshop, to emulate the discussion at the start of the workshop that in the past was so difficult to lead. There were no tutor contributions online, students had to construct their own suggestions between themselves, through an iterative process of submitting their responses online, reading and assessing other students responses to the tasks, and editing their own responses.

Here are some examples of the kind of online tasks we had in the unit *Design of science* during the trial phase, grouped by categories:

Design of strategies. There was one such online activity for each of the four projects, which had to be completed before the start of the workshop where the relevant project would be discussed. Students were asked to read the project requirements and think about how they were going to carry it out. For example, in the project that involved answering the question "How does the wing length of a gyrocopter affect its flight time", students had to think of a hypothesis and design an experiment to test it and submit their design before the next workshop for other students to view. In the past, this was the topic of a discussion conducted by the tutor at the beginning of the workshop, which proved to be hard to lead because students came unprepared or did not know where to start, and in many cases the tutor fell under the pressure of giving too much guidance. With the online tasks, students were able to write up their own hypothesis and experimental design, supported and re-assured by the responses given by their peers. The tutor, who read students responses before the start of the face-to-face workshop, could tailor the discussion around these, focussing on the main points and clarifying aspects that showed to be poorly understood.

Commenting on and sharing of results found. This was also an activity that appeared very often as all projects involved either collection or modelling of data. This kind of online activities required students to post numerical summaries and interpret their meaning. For example, in the project that asked for the average surname length of people living in Melbourne, after designing the sample survey, collecting the data and calculating the numerical summaries, students were asked to post the mean and standard deviation and explain their meaning. Students then used the summaries posted by their peers to interpret them in the context of the Central Limit Theorem. This exercise might look very simple, but proved to be very useful for students to understand the meaning of the standard deviation and the standard error.

Assessing someone else's work. This approach was used early in the course in the context of scientific writing, with the aim of helping students to become aware of the structure and style used in scientific reports. They had to read two pieces of work from students who undertook the unit the previous year and comment on the good and bad points of each of them. This was another case where the online task, which students carried out by sharing their responses, proved to be much more effective than a face-to-face discussion lead by the tutor.

Reflection. A reflective online activity was included at the end of the semester. Students had to elaborate on what they learned in the unit, what progress they made in the development of the intended generic skills, and where would they apply these skills.

Feedback. In the workspace for each week, students had the option to provide feedback on their personal development, on the unit as a whole or on a particular aspect of it. The feedback could be either anonymous or signed.

2.3 Evaluation

The trial involved an ongoing evaluation including the observation of the development of students' online responses, student online feedback (signed and anonymous), fortnightly interviews to the members of the teaching team, and a student focus group interview at the end of the semester.

Overall, the results of the trial were very positive and encouraging. The tutors already had the experience of running workshops for this unit for at least one semester, so they could compare the student engagement with the unit to their previous experience. Reports from tutors indicate that students kept a more consistent working pattern throughout the semester and that students' understanding of what they were required to do improved. The rate of successful completion of project work also improved significantly. Some workshop groups were however, more successful than others in remaining engaged with the unit and in their performance; it was established that this was due primarily to the tutors failure in conveying to the students the role of online activities in the process of construction of knowledge, and could be prevented in the future with appropriate training.

Observation of the evolution of students' responses and interview with students also indicated that many students were using the sharable and editing facilities of the online tool: very often they modified their responses after reading the responses of their peers. This was particularly more noticeable in the first half of the semester; "feeling confident about what was required to carry out the project" and "too many assignments for other subjects" were the main reasons given for it.

It was also observed that a few shy students, who would normally not participate in class discussion, were very active in the online environment, and often they were the brave ones to publish first the response to an activity for their peers to see.

Through the online feedback, which was unsolicited and had an open format, the most often comment students made about the online tasks was that they helped them to keep the consistent pace required by the unit throughout the semester.

3. Text-based online activities in the context of mathematics learning

Our experience shows that online activities that facilitate the construction of knowledge and understanding between groups of students could have a positive impact on the students' first year experience. It could help students to have a sense of belonging to a learning community and improve their chances of success. It is also an approach that fits better with the current students' lifestyle and commitments.

Our experience also shows that such online activities, even though they are primarily text-based, could also work in the context of mathematics teaching and learning. Text-based online tools cannot be used easily to publish information which includes mathematical symbols, but they can still play an important role in setting a rich collaborative learning environment. All examples of types of activities given in §2.2 still apply in the context of mathematics:

Designing strategies could be used to force students plan ahead how they would tackle a project, what will be the steps to follow and how will they know that the results are correct.

Commenting on and sharing of results found. Very often students solve a problem (either by hand or using a mathematics software) but do not stop to think whether their result makes sense. In many settings, such as statistics, a further activity could involve the use of the results obtained by the whole class group.

Assessing someone else's work could also become a powerful learning experience; with creativity, online activities could be designed which only require text-based assessment. For example, the teacher could publish on a website the solution to a problem given by a former student, carefully labelling the various parts of it, and ask students to explain in words what they think about specific parts of the solution or to provide an overall assessment.

Reflection is also a powerful learning activity, one that is not used very often in the context of mathematics. For example, asking students to elaborate on what they think they learned by doing a particular assignment or after a module was completed, and how did that relate to other things they know, could help them to take deeper approaches to learning.

There are many other possibilities. For example, text-only online activities could be designed to help students understand proofs, with an online task that requires them to comment on a proof (published on a web site with labels for the important parts), focussing on a particular assumption, or explaining why a particular step was necessary.

In summary, the possibilities are numerous, limited only by the imagination of the teachers. The examples given here assume that the teaching and learning of mathematics focuses on problem-solving situations, with an emphasis on explanations, justifications and activities that require students to go beyond blind symbol manipulation.

In the case study presented in this paper the specific online tool *InterLearn* was used which has the distinctive feature of allowing the editing of students responses, but similar although somewhat less powerful activities could be designed with the more widely available tools such as online discussion or conferencing tools. The case presented here involves first year students, but a similar approach could be valuable also in to higher years.

4. Conclusion

Online text-based environments could play a significant role in helping students to feel part of a learning community without requiring them to be physically on campus. As shown in the case study presented in this paper, even though the available communication technologies are not yet ready for the handling of mathematical symbols, they could still be used effectively to foster student engagement and deep approaches to learning in mathematics courses.

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