Online discussion in engineering education: student responses and learning outcomes

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Cases on Online Discussion and Interaction: Experiences and Outcomes

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Chapter 5

Online Discussion in Engineering Education: Student Responses and Learning Outcomes

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EXECUTIVE SUMMARY

A ubiquitous and widely used feature of online learning environments is the asynchronous discussion board. This chapter presents a case study of the introduction and evaluation of student use of an online discussion in an engineering management study unit. We introduced an assessable assignment task based on student use of an online discussion, in response to falling student unit evaluation results after we initially moved the unit to wholly online delivery mode. Both quantitative and qualitative unit evaluation data suggest that students perceive value in the online discussion activities. A regression analysis based on discussion usage data suggests that students derived significant learning outcome benefit toward their final unit grade from making reflective postings in the online discussion.

BACKGROUND

Dialogue is considered to be an essential element of human learning, particularly for distance education (Gorsky & Caspi, 2005). It includes interactions between students and teachers, exchanges between students, interactions between students and others not directly involved in their learning processes and dialogue with oneself in the form of reflective thought (Webb, Jones, Barker, & van Schaik, 2004). With the advent of online technologies in teaching and learning, particularly in distance education, the use of online discussion forums is now a widespread medium for learning dialogue. Online discussion can be synchronous through the use of real-time chat tools, but many examples of online discussions documented in the literature present the use of asynchronous discussion. That is, where students post new and follow-up messages to an electronic bulletin-board at the times that suit them, and not necessarily at the same time that other
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students are accessing the discussion system. The claimed benefits of online asynchronous discussion forums include:

- The time between postings for reflective thought that might lead to more considered responses than those possible in face-to-face situations (Garrison, Anderson, & Archer, 1999);
- For off-campus students, two-way communication can be enhanced, reducing student isolation and making possible dialogue with other students (Kirkwood & Price, 2005);
- The convenience of choice of place and time to learners (Cotton & Yorke, 2006);
- The creation of a sense of community (Davies & Graff, 2005);
- The development of skills for working in virtual teams (Conaway, Easton, & Schmidt, 2005);
- Increased student completion rates from increased peer interaction and support (Wozniak, 2005); and
- Increased student control, ability for students to express their own ideas without interruption, the possibility to learn from the collectively created content, the creation of a permanent record of one’s thoughts, the creation of a reusable instructional tool that models expected answers and discussion use, and they create a valuable archive of material for investigation and research (Hara, Bonk, & Angeli, 2000).

Although there is wide agreement that participation in online asynchronous discussions can enhance student learning, and significant work has been done characterizing, and theorizing on the nature of student communications in online discussions, it has also been identified that there is a need to investigate the impact on student course performance of participation in online discussions (Hara et al., 2000). Stacey & Rice (2002) conducted a combined quantitative and qualitative analysis of the online discussion postings of education students studying by distance education in Australia. It was found that those students achieving the highest final unit grade also had the highest frequency of posting, and that lower achieving students were less active online. Although, the authors do not claim these findings as conclusive evidence of the effect of online participation on learning outcomes (as measured by marked assessment activities) (Stacey & Rice, 2002). In a quantitative analysis of two online discussions in the UK involving 543 computing students, it was found that both the number of student accesses of the system and the number of student postings to the system were significant predictors of variance in final mark (in one case) and variance in final grade (in the other) (Webb et al., 2004). Davies & Graff (2005) conducted a quantitative analysis of online discussion usage involving 122 UK business students based on what percentage of all online system accesses related to usage of the online communication system. It was found that students achieving high or medium passing grades were significantly more active in the discussion area than students achieving a low passing grade, and in turn, students achieving a low passing grade were significantly more active than students who failed (Davies & Graff, 2005).

It is noted that although the literature suggests a correlation between increased interaction and increased learning, there is limited research to understand the impact of different types of postings on learning outcomes (as measured by unit final grade) (Conaway et al., 2005). Simply encouraging students to get more involved in online discussions may not necessarily lead to better learning outcomes – there is a need to understand what are the ‘salient factors’ in online interaction that might enhance learning (Davies & Graff, 2005). One debated factor is whether student participation in online discussions should be optional or mandatory. It has been noted that some learning theories suggest that user motives
largely determine how students engage with learning activities; intrinsically motivated learners will invest high levels of cognitive effort regardless of any associated rewards, whereas extrinsically motivated learners may be enticed to participate by gaining unit marks, but their engagement may be instrumental and shallow (Kuk, 2003). Although there is evidence that online discussion interaction carried out on a voluntary basis may lead to better learning outcomes (as measured by unit final grade) (Weisskirch & Milburn, 2003), a pragmatic approach suggests that discussion contribution is likely to be low unless there is some compulsion to participate (Graham & Scarborough, 2001). Students have many competing demands on their time, and if their use of online learning tools is optional, the perceived benefits of participation will need to outweigh the perceived efforts of using the system. In this case, for some students, there may be benefits in providing extrinsic motivators for students to learn and use the system (Garland & Noyes, 2004).

Another form of optional engagement with online discussion forums is ‘lurking’, where students enrolled in a discussion do not make postings, rather they simply read the postings of others. Online system may not detect these lurkers, and the question remains, are these lurkers learning or not? (Hara et al., 2000) There is some evidence that both active participation (posting) and passive participation (lurking) may be beneficial to online discussion users (Webb et al., 2004). A final, but important question about student learning and participation in online discussions relates to the often observed correlation between student participation (number of postings, assessed quality of posting, etc.) and learning outcomes (student final unit mark/grade, etc.). It is often presumed that this relationship is causative, and not simply the result of more able and/or motivated students engaging more deeply with the online discussion than less able students (Cotton & Yorke, 2006). Is it possible that the students with the best results in a unit would have done well in the unit, regardless of whether we employ an online discussion or not?

**SETTING THE STAGE**

The location of the case study presented here is an Australian university that is a major provider of distance and online education. In addition, it teaches on-campus at multiple campuses located in different cities in the State of Victoria. Initially, the University saw itself as a major distance education provider, with some degree of separation between its teaching methods and materials used for on-campus teaching as opposed to off-campus teaching. The use of distance education methodologies and materials for both student cohorts gathered momentum in the early to mid-1990s under the strategic umbrella of flexible teaching and learning, and with a growing ‘technological imperative’ (Holt & Thompson, 1995) for the use of online systems for learning delivery and communication. In more recent times the University implemented institution-wide online teaching and learning systems to provide opportunities to bring together all students in the one learning community. Such inclusively designed online learning environments attempt to provide all students, irrespective of their official mode of enrolment and location, with equal access to learning resources and channels of communication with their teachers, fellow students, and academic and administrative support services. Pragmatically, many universities now confront the need to provide more flexible, time- and/or place-independent study pathways in the face of growing trends towards increasing part-time employment and student mobility. It would seem that even traditional, school-leaver campus-based student cohorts are taking on the characteristics of their mature-aged, in-employment, off-campus counterparts. This is happening to such an extent that we might argue that many students now seem
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to be having the distance-type learning experience to one degree or another.

Online learning environments (OLEs) have been a feature of educational landscape at the University since the early 1990s. Starting first with a range of different systems used in different academic departments of the university, and primarily used for particular courses, units of study or functions, the university gradually moved toward centralization through the implementation of a corporately supported learning management system (LMS). Iterating through a number of commercial LMSs, the university eventually settled on the WebCT LMS in 2003. The new LMS was trialed in 2003, and fully implemented in 2004. Concurrently, the university introduced policies requiring academic departments to migrate all OLE activity to the centrally supported LMS. University policy identified three classifications of online units: Basic Online (administrative support for unit); Extended Online (at least one component of teaching in the unit occurs online); and, Wholly Online (all of the teaching of a unit occurs online), with these categories being analogous to those employed more widely in the sector (Browne, Jenkins, & Walker, 2006). The original definition for being ‘wholly online’ was:

- All content online (either commercial print-based textbooks or commercial e-texts could be used as supplementary material);
- All communication and interaction with students online;
- Assignment submission and feedback online (with examinations moving online when the University was administratively ready); and
- Each unit having at least one session of interactive communication (synchronous, asynchronous, or both) between teacher and students online at least weekly or as established at the beginning of the course.

Such interactive sessions were to have an assessable component where appropriate. From 2004, all students enrolled in undergraduate courses at the University had to undertake at least one unit wholly online, with few exemptions given. Institutional-level research into student use and perceptions of elements of the OLE at the University revealed that, after accessing unit learning materials and administrative information, the next highest OLE element usage is use of the online discussion function (Palmer & Holt, in print), highlighting the importance of online discussions generally at the University.

CASE DESCRIPTION

Technology Use

The School of Engineering at the University has had an eventful history. Inherited from an antecedent Institute of Technology, it was closed in the 1980s and then reborn in the 1990s. Its rebirth saw a School committed to a different type of curriculum and to flexible delivery for its on- and off-campus and offshore students (Holt & Thompson, 1995). At the time of the case study presented here, the School offered a four year Bachelor of Engineering (BE) and three year Bachelor of Technology (BTech) at undergraduate level. The delivery modes of these programs include on-campus, off-campus and off-shore. These programs include the second-year, second-semester engineering management / professional practice study unit SEB221 Managing Industrial Organizations. This unit consists of four modules:

1. Systems Concepts for Engineers and Technologists;
2. Managing People in Organizations;
3. Manufacturing and the Environment; and
Managing Industrial Organizations is a good example of the variety of students within the School. All students study this unit, unless granted exemption due to prior studies or if the student is able to prove they already have the required unit outcome competencies due to work experiences. In 2004, the last time face-to-face teaching occurred, there were 175 students enrolled in this unit. There were 74 on-campus students (a mix of full-time and part-time students), 46 off-campus students (some full-time but mostly part-time students), 50 full-time students studying at a tertiary institution in Malaysia that is a partner of the School, and 5 part-time students in Singapore who receive some local support. Of the 46 off-campus students, most were working full-time, usually in an engineering-related occupation, and might live interstate or overseas. The age range in 2004 for students in this unit was 19 years to approximately 50 years (the part-time off-campus option is very appealing to mature age students). The average age was in the mid 20s. Prior to 2005, on-campus students had access to weekly classroom lectures, and off-campus were provided with printed study guides, with on-campus students generally purchasing the printed study guides as well. All students had access to an online area providing basic resources, including an optional asynchronous discussion forum and the capacity for academic staff to post ‘announcements’ to all class members. The unit assessment regime consisted of two assignments each worth 25 percent of the unit marks and an end-of-semester examination worth 50 percent of the unit marks.

In 2005, this unit was converted to ‘wholly online’ delivery mode, where all teaching of the unit occurred online (Holt & Challis, 2007). A CD-ROM version of the study materials replaced the printed study guides, enhanced with interactive/animated diagrams and video material. Up to this time, the first author had academic responsibility for the Managing People in Organizations module, and was not responsible for unit overall. We made no change to the assessment regime for the initial wholly online delivery.

At the end of 2005, due to staffing changes, the first author assumed full responsibility for the entirety of SEB221, and a review of the wholly online delivery strategy for the unit was undertaken. The University’s policy and procedure for ‘Online Technologies in Courses and Units’ requires that wholly online units be, “…designed to help students to develop their skills in communicating and collaborating in an online environment…” (Holt & Challis, 2007). Although the inclusion of an optional general online discussion area may have met the ‘letter of the law’ for the wholly online unit policy, we considered it inadequate as a means for genuinely developing student online communication and collaboration skills. For 2006, we took 10% of the unit marks from the final examination and dedicated these to a formally assessed assignment activity based around the online discussion area. We retained all other unit assessment items. The following is a summary of the assignment instructions given to students.

This assignment requires you to both reflect on your studies and to constructively engage with the wholly online environment used in this unit. You are required to post reflections on the course material and to comment on the postings made by other students during the semester. You have two types of task in this assignment.

Task 1: Reflect on the course material you have studied in the current week. Identify what you think is the most important topic, access the online system for this unit, open the Assignment 1 forum area for the appropriate week, select ‘Compose Message’ and post a few paragraphs on your selected topic that explain why you think it is important.

Task 2: Review some of the Assignment 1 posts made by other students and select one to comment on. With that message open select ‘Reply’ and post a follow-up to the original message. You may add
your own additional thoughts/reasons for why that topic is important, you may wish to contribute an example related to that topic from your own experience, or something else.

You need to make at least five postings for each type of task given above, i.e., at least ten postings in total, five of type one and five of type two. You should make only one of each type of posting in a given week. Only the best posting for either task type in a given week will be marked. If your postings demonstrate constructive and thoughtful reflection, you will be awarded up to 1 mark per posting, up to a maximum of 10 marks in total for the assignment. You can make more than five postings for each type of task to maximize your mark for Assignment 1. Please use your own thought/words, do not simply reproduce the course notes. Please note that the forum areas will not remain open all semester, i.e., it will not be possible to complete all your postings late in the semester.

In summary, students are asked to make at least five ‘new’ postings reflecting on the course material, with up to one mark awarded for each of the five ‘best’ new posts, and, to make at least five ‘follow-up’ postings reflecting on the prior posts of their peers, with up to one mark awarded for each of the five ‘best’ follow-ups. Student participation in the online discussion is ‘mandatory’ in the sense that marks are assigned to participation. As noted previously, the literature suggests that some form of extrinsic motivation is required to ensure a high level of student discussion participation. A weighting of 10% was chosen for discussion participation – this figure is noted in case studies elsewhere in the literature (Graham & Scarborough, 2001; Hara et al., 2000). It was felt that this weighting would provide incentive for most students to participate, while at the same time not compromising the unit assessment regime should there be unforeseen implementation issues with this initial trial of the asynchronous discussion assignment. Strategies to promote a high level of participation in online discussions include requiring a specific number of postings per assignment and/or per week (Conaway et al., 2005). In this case, we combine both these strategies. It has been found that a key element in the effective use of computer conferencing is ‘intentional design’ of the online environment (Harasim, 1991). Intentional design includes designating conferences (online discussion areas) according to the nature of the task (formal or informal), the duration of the task (one week, whole semester, etc.), size of the group (plenary, small group, etc.), etc. We created separate weekly discussion spaces to structure the formal student assignment postings. This permits us to progressively reveal newer discussion areas, and to progressively set older areas as read-only as the semester progresses. We maintained a separate informal area for general unit discussion and questions. As noted, the assignment-related discussion areas did not remain open all semester, to encourage students to engage with the unit material in a timely manner across the semester. Due to the nature of the assignment task, all of the discussion areas are open to all students – there is no separate small-group discussions employed.

**Evidence of Student Perceptions of the Online Discussion from Evaluation Data**

For many years, the University has conducted a student evaluation of teaching and units (SETU) survey at the completion of every offering of every unit. Although the question items included in the survey instrument have varied over time, there is a set of questions common to all survey instruments, creating a longitudinal student evaluation data set. An 18 item survey was used prior to semester 2 2006. In 2006, the survey was simplified to include a ‘core’ of nine questions, which could be supplemented with optional questions relating to particular unit-related aspects, such as tutorials, laboratory work, workshops, etc. The
student evaluation of teaching and units survey asks students to indicate their level of agreement with the question items on a six-point scale with the labels and corresponding numerical values of 1/strongly disagree, 2/disagree, 3/neutral, 4/agree and 5/strongly agree. A ‘NA’ (not applicable) point is also included to allow students to validly respond to an item that does not apply to them in the unit under evaluation. Based on the mean student responses for the 18 survey items for SEB221 over the period 2003-2005, the question items below had a markedly different result in 2005 following the offering of SEB221 in wholly online mode for the first time:

1. The teaching staff of this unit stimulated my interest in further learning.
2. The teaching staff of this unit motivated me to do my best work.
5. This unit was well taught.
6. I had a clear idea of what was expected of me in this unit.
17. I would recommend this unit to other students.
18. The use of on-line technologies in this unit enhanced my learning experience.

The numbers indicated refer to the question item numbers in the pre-semester 2, 2006 survey instrument. Of the question items selected, only questions 5, 17 and 18 have identical or very similar questions included in the semester 2, 2006 and current survey instrument. The survey results provide one quantitative source of data on which to evaluate the student response to SEB221 moving to wholly online mode.

Figure 1 shows the mean student responses to the six survey question items identified previously, for SEB221 for the period 2003-2005 and, where possible, for 2006. The number of respondents and response rate for the student evaluation of teaching and units survey are also given. For 2006, the first author, as unit chair, had access to the complete survey data set, and included 90 percent confidence intervals for the 2006 survey data, based on the $t$ distribution.

When converted to wholly online mode in 2005, except for question item 18, all other reported survey items for SEB221 suffered a significant...
decline in mean student rating. Items 1 and 2 relate to staff/student interaction, and might reasonably suffer in a mode of delivery that eliminates all face-to-face contact. However, prior to 2005 there were many off-campus students enrolled in SEB221, and the average difference in rating between on- and off-campus students for question items 1 and 2 was about 0.3 less for off-campus students compared to on-campus students – there appears to be something more than just lack of contact with academic staff at play here.

Even though the assessment regime remained unchanged in 2005 when the unit moved to wholly online mode, the 2005 survey results for question item 6 suggest that students were less clear about what was required of them. The survey items considered overall measures of student satisfaction with the unit, question items 5 and 17, both dropped significantly with the move to wholly online delivery. Finally, question item 18, asking students about the learning value of online technologies used in the unit, remained about the same in 2005, even though significant effort and resources were invested in the re-development of the unit materials for delivery in the wholly online mode. On the face of it, given that the unit material and assessment remained ostensibly the same over 2003-2005, the principal factor associated with the decline in mean student survey ratings appears to be the change to wholly online mode of delivery. Experience with a large number of such mandatory wholly online units at the University would suggest that a significant decline in student evaluation of teaching and units survey ratings is a common experience. A (negative) discrepancy in student satisfaction between online and face-to-face modes of delivery for the same unit is noted in the literature (Johnson, Aragon, Shaik, & Palma-Rivas, 2000).

For the 2006 unit offering, the comparatively minor change of a formally assessed (i.e. marks attached) online discussion element was made to the unit assessment regime. However, this requirement for regular active and reflective engagement with the unit material, with the associated online environment and with other students appears to have had a beneficial impact on student evaluation of the unit (Richardson & Swan, 2003). It is known that students respond strategically to assessment tasks – they are more likely to complete activities that are directly associated with assessment (James, McInnis, & Devlin, 2002). Based on the survey questions items common to the pre- and post-2006 period, the overall student satisfaction with the unit, as measured by the mean survey rating for question items 5 and 17, returned to approximately the same levels as prior to the introduction of wholly online delivery. Further, the response to survey question item 18 increased significantly, indicating that students evaluated the re-jigged online environment as positively contributing to their learning experience in the unit.

In addition to the numerical scale items included in the student evaluation of teaching and units survey, students are also invited to contribute open-ended comments under the headings of ‘What were the best aspects of your unit?’ and ‘What aspects of your unit were most in need of improvement?’ In 2006, although no comments relating to the online discussion elements of the unit were noted under the ‘needs improvement’ heading, the following two contributions were recorded under the ‘best aspects’ heading:

“The ability to do work in your time when you could fit it in and have constant assignments that helped keep you up to date and informed. The communication between students online was another good aspect.”

“The fact that the exam is only 40% which means hard work throughout the unit is rewarded.”

We take the references to ‘constant assignments’ and ‘hard work throughout the unit’ to relate to the on-going and regular requirement to make
postings to the online discussion. Additionally, the aspect of ‘communication between students’ is explicitly identified as valuable.

Evidence of Contribution of Online Discussion to Student Learning Outcomes

Student participation in online discussions can be analyzed in quantitative terms (number of postings, length of postings, number of messages read, etc.), qualitative terms (does the posting exhibit cognitive/social/teaching presence?, does the posting exhibit knowledge/comprehension/application/analysis?, is the posting on task/off task?, etc.) or some combination of quantitative and qualitative. Quantitative analysis can be performed quickly using system data, but may not yield a complete picture of student engagement in the discussion (Hara et al., 2000). However, qualitative analysis requires the examination of every student posting to classify the content, consuming significant time and is subject to variation in message content classification by different assessors (Cotton & Yorke, 2006).

At the commencement of the semester, we made an initial model posting of the type expected, to seed the discussion and provide an exemplar to students. During the semester, we assessed student postings on an on-going basis according to the published criteria. Both in initial and follow-up postings, we asked students to discuss unit content, hence assessment of the postings is primarily on the basis of the quality/evidence of cognitive presence.

Following the completion of the semester, the following sources provided data on the student demographics and usage of the online discussion area:

- Student age (whole years at the end of semester);
- Student gender (male or female);
- Student normal mode of study (on-campus or off-campus);
- Student course of study (BTech, BE or other);
- Student prior general academic performance (measured at the University by the Weighted Average Mark);
- The total number of discussion messages read (or at least opened) by the student;
- The total number of new/initial discussion postings made by the student;
- The total number of follow-up/reply discussion postings made by the student; and
- The final unit mark obtained by the student for SEB221.

Analysis of the collected data permitted the compilation of the following information:

- Descriptive statistics on the use of the discussion areas;
- Visualization of the patterns of usage of the discussion areas;
- Investigation of correlation (Pearson’s linear correlation coefficient) between data variable pairs; and
- Multivariate linear regression to find the significant independent variables contributing to the dependent variable ‘final unit mark’.

The number of students completing the unit (still officially enrolled at the end of the semester) was 86. The total number of assessable messages posted was 645. The average number of words per posting was 290. Figure 2 shows the distribution of assessable student postings across the semester.

There is a general downward trend in discussion posting until week 8, after which the number of remaining weeks in the semester equals the number of posts required from a student to maximize their possible mark. After week 8 the general trend picks up again slightly, perhaps indicating a belated ef-
by those students who hadn’t actively engaged with the discussion assignment task previously. Figure 3 shows the ranked distribution of total new/initial postings made by students.

The mean number of new postings is 3.8, with a standard deviation of 2.8. The median and modal number is 5, and the range is 0 to 9. Figure 4 shows the ranked distribution of total follow-up/reply postings made by students.

The mean number of follow-up postings is 3.7, with a standard deviation of 5.4. The median number is 3.5, the modal number is 0, and the range is 0 to 47. It is well known that students take a strategic approach to study, and the learning activities they engage most fully with are those most clearly associated with what will be assessed (James et al., 2002). Even though marks were attached to students’ contribution to the online discussion as an overt indicator that participation was considered important, and disregarding students with a final mark of zero for the unit, 16.7% of students made no new/initial postings.
and 11.9% of students made no follow-up/reply postings. A similar rate of students forgoing assessment worth 10% based on participation in an online asynchronous discussion task is noted in the literature (Graham & Scarborough, 2001). Figures 3 and 4 suggest that even those students who did engage with the assignment task only tended to do the minimum required (one new post and one reply post per week, up to a maximum of ten combined) to qualify for the assignment marks on offer. This type of minimum student engagement in an assessable online discussion activity is reported elsewhere (Hara et al., 2000), and reinforces the idea that students are busy, and extrinsic motivation is likely to be necessary to encourage even a basic level of participation in online discussion activities. Figure 5 shows the ranked distribution of total number of messages read by students – technically, the LMS records the number of messages ‘opened’ by students, but this was taken as a proxy measure of number of messages ‘read’ by students.

The mean number of messages read is 149.6, with a standard deviation of 201.7. The median number is 63.5, the modal number is 669, and the range is 0 to 669. Note that the figure of 669 is higher than the figure of 645 assessable messages given above, as it includes some messages posted by students who commenced but did not complete the unit, but that were never-the-less read by the completing students. Interestingly, the modal number of messages read is also the maximum number, indicating that a significant proportion of students read every single discussion posting.

We devised a method for visualizing the message posting profile of all students together as a group. We compute a ranking factor for each student, based on weighting postings early in the semester higher, and postings later in the semester lower. We use this factor to rank order all students from highest to lowest. Figure 6 shows the rank ordered profile of new/initial postings made by students across the semester.

We observe four relatively distinct discussion new posting profiles, with approximately equal proportions of students in each. Students 1-21 (21 students, 24.4%) made their required five (or so) posts, commencing at week one, and then generally left the discussion space. Students 22-44 (23 students, 26.7%) commenced their posts in week

Figure 4. Ranked distribution of total follow-up/reply postings made by students
one and then had a range of posting profiles, typically not continuous, re-entering the discussion space at various points over the twelve weeks. Students 45-69 (25 students, 29.1%) commenced their posts some time after week one and then had a range of posting profiles, typically not continuous, with students who commenced their posting late in the twelve week period exhibiting more intense posting in an attempt to meet the assignment criteria of making five new posts in total. Students 70-86 (17 students, 19.8%) made no postings at all during the twelve week period.

Two significant correlations are observed; final unit mark and weighted average mark ($r = +0.43, p < 4 \times 10^{-5}$), and final unit mark and total number of new postings ($r = +0.49, p < 2 \times 10^{-6}$). Inspection of variable pair scatter plots reveals that the relationship between final unit mark and number of new postings plateaus after five new postings. After the data range for the number of new postings is limited to five or less, the correlation is ($r = +0.59, p < 4 \times 10^{-9}$). As might be expected, a correlation is observed between previous general academic performance (as measured by the student’s weighted average mark), and final unit result in SEB221. The observed correlation between total number of new postings and final unit mark is strongest for number of new posts

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**Figure 5.** Ranked distribution of total number of messages read by students

**Figure 6.** Rank ordered profile of new postings by students across the semester
between zero and five. This is not surprising as, although we allow students to make multiple new postings per week, we only take the single ‘best’ new posting result as the mark for the week. Although both weighted average mark and number of new posts appear to have a positive correlation with final unit mark, they do not have a significant correlation with each other \((r = +0.23, p > 0.033)\), suggesting that they are not significantly multicollinear with the final unit result, and that both contribute independently and positively to the final unit mark.

Following removal of three data items with an unknown (not BE or BTech) course of study and four data items for students with a final unit mark of zero (did not complete unit but did not officially withdraw their enrolment), multivariate linear regression analysis is conducted, with final unit mark as the dependent variable. We initially introduce all other known variables as independent variables, and we perform step-wise regression until all remaining variables are significant. Table 1 shows the coefficients of the regression model and their significance.

An Analysis of Variance test suggests that the regression model is significant \((F_{78} = 47.29, p < 5 \times 10^{-14})\), though the model predicts only 55.4% of the variation in final unit mark \((R^2 = 0.554)\). The regression residuals are approximately normally distributed. The model explains only just over half of the variation observed in the final unit mark, hence there exist other factors with a significant influence on final unit mark that were not available in the data collected for this analysis. The results of the regression analysis support the results of the data pair correlation analysis that both the number of new postings and weighted average mark contribute significantly and independently to final unit mark. Based on the marking scheme of ‘up to 1 mark per posting’, it would be expected, all other things being equal, that posting one new message would add approximately one mark to the final unit result. Instead, the regression analysis indicates that there is a significant benefit (up to three marks per new posting) beyond the notionally allocated marks for new postings. This suggests that the work that students complete in preparing their new discussion postings engages them with the unit material and assists them in the completion of other assessable tasks for the unit.

None of the student demographic characteristics (age, gender, mode of study and course of study) are found to be significantly correlated with levels of participation in the discussion (messages read, new postings and reply postings), suggesting that all students are able to participate in the online discussion exercise on a generally equal basis. It has been proposed that the ways in which students engage with online asynchronous discussions will influence the learning outcomes achieved (Cotton & Yorke, 2006). We used the four types of student engagement with the discussion space identified in Figure 6 as a grouping variable and entered this into the multiple regression analysis, but it was not found to be a significant contributor to final units result.

**CURRENT CHALLENGES**

Although the introduction of a formally assessed online discussion appears to have a positive effect

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<th>Variable</th>
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<th>Standard error</th>
<th>Beta</th>
<th>Significance</th>
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on student engagement with, overall perception of, and learning outcomes from an engineering study unit, a number of questions/issues remain. The regression analysis performed here identifies the explanatory factors contributing to only just over half of the variation observed in the final unit mark. Although active participation in the online discussion is a significant contributor to a student’s final unit mark, what are the other factors not included in the data analysis that also contribute to unit learning outcomes? Although the qualitative feedback comments relating to the unit examined here are limited in number and scope, a larger institution-level survey of students at the University regarding their experiences of learning in wholly online units (Palmer & Holt, 2009) may shed some light on this question. This survey elicited more than 300 written responses from students to the question, “In what ways, if at all, has studying this unit online influenced your approach to learning?” An initial analysis of this qualitative data has been performed (Holt & Palmer, 2007), but a more focused analysis may help understand the full value students find in wholly online study generally, and the use of online discussions in particular.

The case presented here focuses particularly on the use of an online discussion. Both within the tools/features provided by LMSs, and via stand-alone applications that can extend LMS functionality, there is a rapidly expanding suite of e-learning technologies available to educators. An important question arises regarding the best ways in which elements from the range of technologies can be organized and combined into online learning systems to improve learning (Gibbs & Gosper, 2006). What combination of e-learning technologies, chosen from the available portfolio, creates the greatest potential educational value in a given teaching and learning context? A more recent development in the open source arena are “social software” applications, such as blogs, wikis and social networking sites, which have as their essence the collaborative collection, ordering and interpretation of user-created content. These software systems provide new tools inherently aligned to the collaborative and reflective activities underpinning the online discussion application documented here. They offer an emerging and interesting option for the further development of online discussion activities in education.

SOLUTIONS AND RECOMMENDATIONS

As part of an institutional requirement that all undergraduate programs contain at least one ‘wholly online’ unit of study, we converted an existing unit in the engineering program to wholly online delivery in 2005. Initial results from student unit evaluation data indicated that students were significantly less satisfied with many elements of the unit after the move to wholly online delivery. In response to this result, we made some strategic changes to the assessment requirements for the unit in 2006. Using existing student evaluation data sources, we undertook a quantitative investigation to determine how students had responded to these changes to the unit mode of delivery and subsequent assessment changes. Based on student evaluation of teaching and units survey data collected systematically by the University, simply translating existing print-based study resources into electronic/online format, retaining the same assessment regime and dropping all face-to-face contact with academic staff appeared to lead to a significant decline in mean student ratings for a number of survey questions items. This finding suggests that simply performing a ‘direct conversion’ of an existing unit for wholly online delivery may not produce the optimal result for student satisfaction and learning.

By making a minor change to the unit assessment in 2006 to incorporate a formally assessed activity that requires students to regularly reflect
on the course material and participate in an online discussion area, student evaluation of teaching and units survey item ratings common across the period 2003-2006 show a recovery to their prior levels. Additionally, the item relating to the value of online technologies in student learning actually rose significantly. These findings suggest that careful thought, but not necessarily major changes, may be required to avoid student disillusionment and to maximize student learning outcomes when moving an existing unit to wholly online delivery format. Although we qualitatively observed that student participation in unit online discussions increased significantly compared to previous unit offerings, following the introduction of a formally assessed online discussion task, we undertook a quantitative examination to investigate the impact of the students’ participation in the online discussion on their final unit results.

We observed that, although many students read a significant number of discussion postings, generally, the posting of new and reply messages occur at the minimum level required to qualify for the assignment marks. Based on new postings to the online discussion, we observed four distinct patterns of posting. Based on correlation and multiple regression analysis, we observed a significant relation between two measured variables and a student’s final unit mark – their weighted average mark (used as a proxy measure for general prior academic ability) and the number of new postings that they make to the online discussion. In addition, these two variables are not significantly correlated with each other, and are both significant in the regression model obtained, suggesting that both contribute independently to the final unit mark. Although we shouldn’t interpret it literally as the ‘formula’ that determines a student’s final unit mark, the regression model explains more than half of the observed variation in final unit mark. Additionally, it does suggest that the influence of active participation in the online discussion assignment through the posting of reflective contributions based on the course material makes approximately the same contribution to a student’s final unit mark as their general prior academic ability. Further, the regression model indicates that each new posting contributes three times as much to the final unit mark as its nominal assessment value of ‘up to 1 mark per posting’ otherwise indicates. This suggests that the work in preparing their new discussion postings engages students with the unit material and assists them in the completion of a range of assessable tasks for the unit. However, although active contribution to the online discussion in the form of new posts is a significant factor in the final unit mark, simply reading the posts of other students is not. The number of postings read is not significantly correlated with the final unit mark, suggesting that passive ‘lurking’ in this online discussion does not significantly contribute to student learning outcomes (as measured by final unit mark).

REFERENCES


**KEY TERMS AND DEFINITIONS**

**Engineering Education:** Those university-level programs leading to the award of a qualification recognized as adequate/appropriate for graduate membership of the national engineering professional body, and normally granting the holder the right to begin professional practice as an engineer.

**Assignment:** A summatively assessed activity in a university education program undertaken by students for credit/marks in a specific unit of study.

**Learning Management System (LMS):** A system designed for the delivery, tracking and management of education and/or training. Such systems typically use the Internet for the online delivery of learning programs, provide tools for management online assessment and offer various forms on online collaboration and communication. Historically, LMSs have been commercial software packages, but an array of open-source systems is now available.

**Online Learning Environment (OLE):** A system designed specifically to support online teaching and learning (as distinct from an LMS – though the distinction is becoming harder to define). An OLE may include an LMS as a foundation, with additional tools for supporting online teaching and learning provided in parallel. An OLE (however constituted) might provide the following features/tools: online assessment, communication tools, uploading of content, peer assessment, student group administration, questionnaires, wikis and blogs. Although originally aimed at supporting distance education students, OLEs are now commonly used to support on-campus enrolled students as well, in a form education known as blended learning.

**Learning Outcome:** The knowledge and/or skills and/or abilities that students have attained as a result of their involvement in a particular set of educational experiences. Learning outcomes are typically summatively assessed through a range of assignment activities which contribute to a final mark in a unit of study.
**Asynchronous Discussion:** An online discussion forum that does not require all participants to be present (physically and/or virtually) at the same time. Contributors can post a message that can be read/responded to by another participant at a different time. Conversations and an online community can develop over time.

**Student Evaluation of Teaching (SET):** In its most general form, this includes any method used to obtain feedback from students regarding their perceptions of their teaching/learning experiences. Commonly, this will include an end of semester/term survey of students to quantitatively assess their perceptions of unit content and/or teacher performance.