Engineering and re-engineering learning discussions in a fully online unit

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***Abstract**: Online discussions are a key feature of many e-learning environments, incorporated for a range of contextualised pedagogical and social reasons. These reasons include the desire to create a sense of learning community where knowledge, experiences and understandings can be shared and co-created, and the opportunity to create a space where higher order thinking and critical reflection can be encouraged. This paper explores the various design issues to be addressed, and decision points, in formulating an effective online discussions program aligned with course objectives that seek to promote higher order thinking and learner engagement.*

Introduction

Online asynchronous discussions have become an integral part of fully online courses, and are increasingly being used to support teaching in on-campus programs. They allow students to communicate with each other and their teachers via the web at a time and place of their choosing, usually within a defined time period. The purported benefits of online discussions in the context of distance education programs include:

Social benefits: making possible dialogue with other students and staff, online participation can help break down the sense of isolation that many distance students feel, and create a sense of 'learning community', albeit virtual. Communities can provide member support and encouragement, and reference points for students to benchmark their progress.

Pedagogical benefits: discussions can facilitate knowledge sharing and community knowledge building. Social constructivist theory posits that knowledge is usually built or constructed in social settings through cycles of interaction and reflection on experiences and understandings' with the implication that learning occurs through interaction with peers just as much as with interaction with teachers and learning materials. Discussion can also promote higher order thinking through critical writing and reflection, certainly a desired outcome in pretty well all postgraduate courses. The time leeway between postings allows for more considered thought and research than is possible in face-to-face situations.

Student management benefits: regular discussion can keep otherwise busy students on track and on schedule. Discussion participation also provides a window for teaching staff on students' thinking and progress, and can signal the need for assistance or intervention.

Online discussions in engineering education

In the field of engineering education, online discussions have been used as a collaborative tool to support group-based problem solving and project work at undergraduate level, both distance and in blended (mixed face-to-face and online) programs. Examples from past AaeE conference proceedings include, Cochrane, Bodie and Pendlebury 2008, Sher and Williams 2006 and also Maier and Baron

(2005) who describe a community of inquiry framework for an online roleplay simulation using the approach of Garrison and Anderson's (2004). The focus for our current study is in the development of critical thinking, and less so in the social and personal dimensions of discussion. Discussions lend themselves to situations of complexity, ambiguity and where open-ended solutions are possible (divergent thinking), and less well to situations where solution pathways are well defined and end points clear (what might be called convergent thinking). Online discussions may thus have significant value in engineering design and design thinking, which share much of the attributes of divergent thinking, interweaved with more analytical thought processes (McAlpine, Reidsema and Allen 2006).

Despite the purported benefits of online discussions, the outcomes can often be disappointing. Student participation may be patchy and variable such that functioning learning communities fail to emerge. Numerous studies have shown that cognitive engagement in discussions can be minimal, with postings more like serial monologues rather than real engagement with the ideas of their peers (Bullen 1998). And of the interaction that does occur, it may rarely go beyond the sharing of information and identification of group dissonance, and so fail to invoke higher order thinking skills in building community understanding (Kanuka, Rourke and Laflamme 2007, Gilbert and Dabbah 2005). In an analysis of postings carried out bythe authors in the course unit from 2008, we found a similar situation. Using Garrison's four-stage model of cognitive engagement to categorise postings, we found close to 70 percent of all contributions were at the level of 'Exploration' (the second level); 25 percent at the next level (Integration') and only around 2 percent at the highest, fourth level ('Resolution'). Furthermore, some discussions engendered little student input (Jackson & Lawrence, 2008). In Garrison's model, *exploration* involves information exchange, brainstorming and ideas presentation; *integration* involves making connections, converging understandings, synthesis, positing solutions; *resolution* involves testing, applying or defending solutions. Stage 1 is the *triggering event* (question, hypothesis) that initiates the conversation (Garrison, Anderson and Archer 2000).

Reasons for discussion failing to achieve desired outcomes may lie in matters of design, students' orientation to discussion, or management of the discussion as it unfolds. This paper is largely about discussions design, but also addresses other preparatory matters before the discussions begin. As Goodyear 2002 puts the situation succinctly:

> *'Neglect of task design tends to have two consequences – either students flounder around unproductively and unhappily, not knowing what is expected of them, or tutors find themselves spending much more time than they can afford trying to animate online discussions'*.

Our aim in this paper is to provide practical advice based on the literature and our experiences in delivering a fully online unit *Design of Marine Machinery Systems* (DMMS). The unit was first offered in 2008 by the Centre for Marine Engineering and Hydrodynamics at the Australian Maritime College as part of a masters program for employees of the Australian Submarine Corporation in Adelaide. In the light of that experience and review of the literature, the discussions program has been revised for 2009.

Design considerations

There are four major considerations to the design of online discussions:

1. Integration of discussions into the overall unit program (the 'place' of discussions)
2. The content design of individual discussion topics (the 'what' of discussions)
3. Interactivity considerations (the 'how' of discussions)
4. Links to assessment (the 'worth' of discussions).

As a focus for discussion, figure 1 provides a framework of these various design elements.

Unit design

Various facets need consideration here. Firstly, discussions need to be clearly integrated with other curriculum elements, course goals and assessment, and have a clear purpose evident to students. As Walker and Arnold (2004) put it, discussions *'..need to be linked, complementary and woven into the*

fabric of the course'. This won't happen if the discussions program is simply bolted onto the end once the major curriculum and assessment decisions have been made. In DMMS, the discussions were integrated with the topics/modules structure and incorporated into assessment.

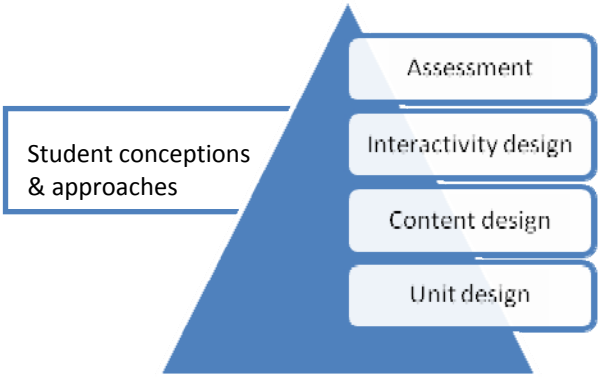

Figure 1: Online discussions design considerations

Secondly, the number and placement of the discussions over the teaching semester needs consideration. For our first offering there were eight separate discussion topics spread across the full teaching semester, each occurring over a 7-10 day period. Logs indicated a significant drop off in engagement towards the end of semester, no doubt linked to students' preparation for the final assessment. Consequently, we have adjusted the number of different topics to six and kept the last three weeks of semester clear of discussions. That students adopt a surface or strategic (pragmatic) approach to study when faced with heavy workload or time constraint pressures and disengage to complete assessment tasks is noted by Downing, Lan, Kwong, Downing and Chai (2007), who advise, '*..it is not effective or worthwhile to attempt to sustain online interaction for the duration of the whole course'*.

Content design

This relates to the particular purpose, nature and focus of the discussion topic. A useful starting point that addresses both social and cognitive aspects of discussions is Gilly Salmon's 5-stage model of online learning through networking. Discussions begin at Stages 1 and 2 with online socialisation and familiarity with the technology, move through to stage 3 - information exchange, and then progress to stages 4 and 5 that invoke higher order thinking and engagement (Salmon, 2000). The first two topics essentially follow Salmon's model, with topic 1 focussed on socialisation and topic 2 progressing information exchange (part 1) then more critical review of that information in part 2 (see Table 1).

But what makes for a good discussion topic? In a study of undergraduate business and accounting students' views of online discussions, Gerbic (2006) found that students *'...stressed the importance of contemporary and substantial issues [or problems] that required thought, interpretation and application of course concepts*', and discussion that encouraged '*multiple responses with room for sharing ideas and agreement and disagreement*'. Others have argued for the value of such open-ended, divergent 'triggers' for discussions, in comparison to more convergent discussion tasks that leave little room for different opinions or outcomes. So we sought engineering design issues, problems or cases that would provide for multiple perspectives, encourage divergent thinking and lead to a deeper and richer exploration of the issue/problem. Benfield (2002) provides further design pointers – that discussions be clear, focussed and task-oriented, well structured, and lead towards development of 'products' that can be used in other learning activities such as assessment tasks.

In terms of higher order thinking, our analysis of postings from the first offering revealed a preponderance of items at the 'exploration' level in Garrison's 4-stage model of cognitive engagement, and so three of the discussion topics have been restructured to directly lead students to the higher levels of engagement, integration and resolution, manifested as the second parts of topics 3, 4 and 5 (see Table 1).

Table 1: Discussion topics schedule

Wk	Topic
1	**1**. ***Your background***: Post a short piece to our class blog in answer to the following questions: 1. What previous experience have you had (if any) in design of machinery systems? 2. What has been your worst/best nautical experience so far? [Class Blog – 8 days]
2	**2. *Propulsion system options for Australia's proposed Collins Class submarine replacement*?** Following the recent Government Defence White Paper 2009, it is highly likely that the 12 Collins Class replacement submarines are to have an air independent propulsion system. **Part 1**: As a small working group, you are to research one of the following two options for air independent propulsion system – fuel cells; stirling engine: Your group is to post a summary (of no more than 300 words) of the appropriateness or otherwise of your option to this class topic discussion. There is separate group topic discussion area should your group choose to use it. Your subject is the chosen propulsion system. Your response should include the reasons for your judgment and the working assumptions that you made. [Class Blog – 7 days]
3/4	**Part 2**: On the basis of the group reports, what do you, *as an individua*l, think is the most likely option to be chosen. Why or why not? [Threaded – 7 days]
5	**3. *Biofuel blend with NATO F-76?***:Experts are suggesting that beyond 2030, supplies of petroleum based diesel fuels will be significantly diminished. What might be the likely effect of incorporating a blend of 20% Biofuel and 80% NATO F-76 fuel on the design of fuel oil systems used the Australian Naval Fleet? You will need to research the nature of biofuels before considering aspects such as: storage life and / or capacity, interaction with materials. [Threaded – 8 days]
6	***Lessons learnt from past engine room fires: Part A-search and report*:** What have we learnt from past engine room fires? Research an engine room fire incident of your choice. Prepare a list in bullet point form of the implications that the incident has for marine machinery systems designers. Cite your source (web site or journal, etc.). Here are two web sites that can get you started [not included here]. [Class Blog – 7 days]
7	***Lessons learnt from past engine room fires: Part B -analysis and conclusions*:** From these cases can we draw some basic design fundamentals? What might these be? For example, can we group these implications in some way as a first step? [Threaded – 7 days]
8	***AC versus DC for diesel electric submarine propulsion motors: Part A-brainstorm*:** Is there any future for the next generation of electric propulsion motors for submarines to be AC? To answer this question your collective task is to brainstorm the relative **advantages** and **disadvantages** of each system and any **other factor**s, (e.g. technology changes) that might figure in the final decision. Add your thoughts to this blog under these three headings. [Class Blog – 7 days]
9	***AC versus DC for diesel electric submarine propulsion motors: Part B-analysis*:** Do you think the advantages of using AC outweigh the disadvantages? Why do you think so? How might the factors identified in Part A impact on the discussion? [Threaded – 7 days]
10	***Current Issues in Marine Machinery Systems:*** This is the topic for our virtual conference. For information about this conference see Assignment 2. [Class Blog – 5 days]
11-13 ***No discussion period***	

Interactivity design

This involves consideration of the 'mechanics' of discussion; the particular discussion environment in which discussion is to occur, the interactivity processes, and the time window for that interactivity.

Blackboard Vista, the UTAS online learning management system, provides two types of group discussion environment: *threaded discussion*, where questions and their replies are presented as a thread (to view the thread the postings need to be expanded and opened individually), and *Class blog*, where entries are displayed on the one page in chronological order, with provision for the addition of comments by other class members. Blogs are thus useful devices for communal information sharing, and threaded discussion for delving more deeply into a topic; i.e. in Garrison's cognitive model terms, blogs for 'exploration', and threaded discussion for 'integration' and 'resolution'. Accordingly we have increased the proportion of threaded discussions, largely by adding and linking them with an initial class blog to establish a knowledge base for the ensuing discussion.

Size of the discussion group is an important factor for effective participation, with groups of 5-8 cited as optimal for individual involvement, ideas generation, and overall management (Benfield 2002). With enrolments of that order, size was not an issue for us. However, for specific teamwork associated with discussions, we set up groups of three to maximise input and accountability, and created private discussion areas for each team (see discussion topic 2).

The time window for interactivity is also another significant consideration. There is a need to balance the need for time flexibility, of particular importance where students are juggling work, family and study commitments, and the need for focus and closure. Too wide a time window can lead to messages so spread out and irregular that systematic knowledge building is near impossible; too narrower a window and students won't have the time to contribute thoughtful, researched and reflective ideas (Dennen 2005, Salmon 2000). Windows of 1-2 weeks have been our response to this dilemma.

One final consideration is the role of the moderator in orchestrating interactivity. Clearly, the interventions of the moderator during the discussions are critical to the quality of outcomes, and the literature on moderator techniques and strategies grows by the day. For example, in regard to framing questions that will stimulate, not close down, discussions, see Toledo 2006. But in terms of design, decisions need to be made regarding who will moderate—staff or designated students— and the specific role of the moderator; for example, 'starter', 'wrapper', 'weaver' etc. In most of our discussions staff play the moderator role; however in the online conference, each student presenter is responsible for the starter trigger and general discussion progress.

Assessment

Participation in discussions can be directly assessed holistically at unit level, or particular discussions assessed. Our model uses a mix. Ten percent of the overall assessment for the unit was allocated to the quantity and quality of engagement. In addition, 7 percent was allocated to discussion in the online conference, as part of the second assignment. Because of its significance to assessment, this online conference blog generated close to 50 percent of all postings across the topics, indicating the power of assessment to drive participation. We have chosen to keep with this model and review the situation after the second offering of the unit. Consideration is also being given to incorporating peer assessment into the handling of questions during the conference. Although there is some debate about forcing participation through direct formal assessment (see for example, Strijbos, Martens and Jochems 2004), the general consensus is that this practice signals the value attached to meaningful participation in discussions.

Students' conceptions and approaches to discussions

Student responses on an end of semester survey strongly hinted that students held differing views as to the purpose and value of online discussions in the unit (Jackson and Lawrence, 2008), tentative findings consistent with the work of Ellis and his colleagues at Sydney University (Ellis, Goodyear, O'Hara and Prosser 2007). These authors identified four levels of conceptions of learning through discussions and four corresponding approaches, ranging from 'surface' to 'deep' engagement. To clarify purposes and desired approach, for the second iteration we have distributed a student guide, 'Engaging in online discussions' and an assessment rubric with descriptions of the standards of engagement expected, strategies found by Gilbert and Dabbagh (2005) to increase 'meaningful discourse'. Addressing students' conceptions and approaches as a 'backdrop' to design considerations is shown in figure 1.

Conclusion

Four major design considerations have figured large in engineering, and re-engineering the discussions program in DMMS, in addition to the need to address student conceptions, and hence approaches to online discussions. We hope that this will be of practical value to others considering similar initiatives. One of the great benefits of online discussions is the written record they leave, providing an invaluable window on students' thinking. That information can assist staff in improving and refining the discussions, and improving the unit in general.

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