Exploring discipline differentiation in online discussion participation

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Online discussion forums are often the only interaction or communication a student in an online learning environment will have with the course instructor and fellow students. Discussion forums are intended to elicit a range of thinking skills from the students, from purely social interaction to metacognition in order to achieve deep learning. Given the increasing use of online learning environments, it is timely to question whether students from different disciplines use online discussion forums in different ways, particularly in terms of their level of thinking. If there is differentiation, educators need to provide discipline specific opportunities for undergraduate students to interact in dynamic online discussions as part of a rich learning experience. This ethnographic study explored the types of online postings provided by students as part of their learning journey in two undergraduate online courses, one in an Engineering program and another in a Teacher Education program at a regional university. The goal of the research was to identify evidence of higher order thinking within students' online posts. Data were analysed according to Henri's Content Analysis Model for Asynchronous Conferencing.

Introduction

In an online learning environment, educators depend greatly on discussion forums to replace the conversation, questioning, and debate that would have arisen in a face-to-face classroom situation. Substituting the discussion forum for the classroom is, however, not a straightforward process. The asynchronous nature of online discussion forums and the lack of face-to-face contact not only depersonalises the interaction, but also provides greater opportunity for lurking as opposed to active participation. Online forums across disciplines do not spontaneously evolve into vehicles for higher order thinking. These forums need to be designed, facilitated and managed to elicit specific outcomes.

Online engagement

Knowledge construction and learning requires students to interact and engage at a range of levels rather than exhibit passive participation (Dewey, 1933). Student engagement has been explored by many researchers (Astin, 1999; Kuh, Schuh, & Whitt, 1991; Pascarella & Terenzini, 1991). However, it has been suggested by Bowen (2005) that there is no "consensus about what we actually mean by engagement or why it is important" (p. 3). Nevertheless, McLoughlin and Luca (2000) commented that "[o]ne of the most pressing issues is to discover how to support intellectually productive interaction and foster higher forms of cognition" (p. 3). It has also been advocated by Fowler and Mayes, (1999) that "engagement and construction are both about doing and discovering" (p. 5). In an online environment, discussion forums can provide a valuable means of engaging with course material and constructing knowledge through dialogue. There is limited literature exploring differences in engagement or interaction between face-to-face courses and online courses and also whether the instructor expectations are the same across both environments. Enhanced learner engagement and learning outcomes occur during online interaction where theoretical concepts of the course are connected to the real world and there is ongoing interactivity between students and educators.

Visible and vicarious engagement and learning

There is an inherent value in online dialogue as evidence of student learning, engagement and understanding of theoretical concepts. The visibility of this learning is important in the provision of effective and efficient support for students throughout the learning process; for example, to counter misunderstandings and misconceptions prior to the completion of assessment, and enhancing the learning experience and outcomes of students.

This idea is conceptualised in the social theory of Stahl (2006), who highlighted the idea that learning is a knowledge-creation process as opposed to a knowledge-acquisition process. He acknowledged the role of collaboration and communication with others on an individual's interpretation of knowledge, thus conceptualising learning as a meaning-making process. Therefore, by its very nature, online collaborative learning ensures the learning process is made visible to educators and peers (Stahl, 2006). This visibility provides researchers of online education with the methodological foundations for empirical analysis and the ability to analyse the process of meaning-making as it occurs. From a teaching perspective, it is evident that the online environment provides a key educative role in allowing students the opportunity to share, question, and build knowledge through interactive communication, diverse interpretations, and meaning-making processes.

Taylor (2002) has suggested there are three main types of students in online courses: the 'workers', the 'lurkers', and the 'shirkers'. The workers are proactive in their participation and are very visible. They regularly respond to the messages of others and start their own threads. The lurkers have regular but peripheral participation in that they are regularly in the online space but are in 'read only' mode and do not leave a visible mark that they have been present. Finally, there is the "parsimonious participation group" (Taylor, 2002, p. 7) who are the shirkers, who are online less often than the other two groups and often make up a high percentage of students who do not complete or fail the course.

The concept of vicarious engagement or 'lurking' was first introduced by De Vries (1996), who highlighted the concept that students with no visible evidence of public participation are still able to benefit from online discussion tools by observing "the interactions of others" (Sutton, 2001, p. 232). Students may be "actively listening" or "lurking" by reading the contributions of their peers but not participating in the discussion and still learn from that conversation (Schallert, Reed, & the D-Team, 2003). However, it is critical to consider that effective engagement and consequent learning is not guaranteed simply by providing online content and encouraging online interaction (Garrison & Cleveland-Innes, 2005). The reality is that in both the face-to-face and online environments, students do lurk, or are passive, rather than actively participate in academic dialogue. Lurkers are bystanders who "lack commitment to the rest of their class community and receive benefits without giving anything back" (Ebner & Holzinger, 2005, p. 71) to the discussion. Instructor expectations of the interactions for members of the class should be made explicit, especially if the ongoing interaction is an aspect of the course design or is related to the course assessment. Conversely, there will be courses designed with no or limited interaction between students.

It must be emphasised that the quality of discourse is far more important than the quantity of discussion posts. Garrison and Cleveland-Innes (2005) highlighted the importance of the educator in constructing effective dialogue in order to achieve high levels of critical and reflective thinking in students. This enables students to construct and deconstruct knowledge by drawing on personal experience and the experiences of others integrated with academic literature. Therefore, the lack of student participation and limited cognitive engagement from students on online discussion forums may be linked to the design of the forums and the quality of educator facilitation. Muilenburg and Berg (2000) linked the quality of the questions being asked by educators with the quality of educator facilitation, highlighting the importance of asking the 'right' questions rather than "giving the right answers" (p. 2). Lipman (2003) suggested that "questioning is the leading edge of inquiry" (p. 99) and is, therefore, critical for improved learning outcomes.

Finally, it must be acknowledged that educators, in their focus on the construction of effective dialogue, can fail to recognise the ability of students to learn vicariously by reading the contributions of other students. Raising the quality of online discussion can be linked to the ability of students to critically engage with knowledge. Having said that, students who 'lurk' in online discussions have the ability to learn just as effectively and efficiently; even when not actively participating in the dialogue they may be actively engaged with the discussion and material.

Critical thinking

With the proliferation of information communication technologies (ICTs) has come the rapid exchange of information that can support the process of deep learning. This occurs when the "learner seeks information actively, uses it to produce knowledge, and integrates these into his or her cognitive structures" (Henri, 1992, p. 123) through purposeful and intellectual activities. A constructivist learning environment enables students to become knowledge creators rather than knowledge consumers and is fundamental in becoming a life-long learner: a complex thinker, a creative person, an active investigator, and an effective communicator (Lawson, Askell-Williams, & Murray-Harvey, 2006). For the education system to instil and develop the qualities of a lifelong learner, we must embark on providing a constructivist learning environment, which will improve the quality over quantity of students' thinking.

In order to improve the quality of thinking, one must define and understand it; "[G]ood thinking is accurate, consistent and coherent thinking…it is ampliative, imaginative, creating thinking" (Lipman, 2003, p. 2). Lipman (2003) also suggested that thinking links ideas, which in turn can promote higher-order activities, for example making judgments and justification. Halpern (2003) concluded that there is a necessity for thinking "that is purposeful, reasoned, and goal directed" and that is essential in "solving problems, formulating inferences, calculating likelihoods, and making decisions" (p. 6). It is important to distinguish between critical thinking and problem solving; while they are often interchanged, they are different. While problem solving skills may be used in complex problems, they are "usually well-defined and have one or perhaps two correct answers" (Bruning, Schraw, Norby, & Ronning, 2004, p. 180). Bruning et al. (2004) also revealed that critical thinking differs in that consideration is given across several disciplines in order to find a solution to a messy or unstructured problem.

Furthermore, while there is consensus amongst scholars (Ennis, 1996; Facione & Facione, 2007; Lipman, 2003; Paul, 1982) that critical thinking is founded on the possession of specific skills; there is disagreement on what these skills are. Ennis (1996) proposed that the skills are logical and therefore are able to be taught and transferred between disciplines. Facione and Facione (2007) believed these skills are a "combination of analysis, interpretation, inference, explanation, evaluation and fair-minded self-correction" (p. 44), while "knowledge, inference, evaluation and meta-cognition" (Bruning et al., 2004) are deemed to be the most imperative skills for critical thinking. Paul (1982) highlighted the ability of students to critically consider the views of others, different perspectives, and the ability to see the big picture, achieved through discussions with others, as high-end critical thinking skills. Whereas Lipman (2003) concluded that it is not enough to know what these skills are, one must "know how and when and where to use them" (p. 189).

Consideration must also be made to the idea that there are crucial dispositions and personality traits that enable some students to be more successful at critical thinking. Facione (2007) highlighted several key dispositions, such as "courageous truth-seeking, open-mindedness, persistence, intellectual integrity…and maturity of judgment" (p. 44). Lipman (2003) was more succinct with an analysis of essential dispositions, seeing the importance of "wondering, asking for reasons, judging with criteria and questioning" (p. 187). It is evident that scholars have a clear understanding of the make-up of critical thinking and its importance in the creation, application, and retention of knowledge.

Students can cognitively participate in online dialogue but at a surface rather than deep level (Henri, 1992). Students who demonstrate superficial interaction might repeat or agree with previous information or opinions without offering interpretation or new comments, or they propose solutions or judgements without explanation or justification. In contrast, those students engaging at an in-depth level will critically evaluate information, make inferences, predict consequences, compare and contrast information, draw conclusions, or connect the new information with their past views or experiences. Even when 'fast posters' have revealed their ideas, suggestions, or experiences, students with in-depth processes can build on that information using the above actions to enhance the quality of the discussion. These attributes are related to a higher level of thinking or in-depth processing and are more likely to result in high levels of knowledge acquisition and problem solving (Henri, 1992). These aspects of critical thinking can be explicitly explained, modelled, taught, and expected within courses to support students' development not only of the thinking skills but also of enhanced knowledge development in their discipline.

Traditionally, educators focus on what students are 'doing' and this is their primary aim when creating interactive learning environments. Online activities and discussions focus on students interacting with educators, peers, industry professionals, and the course content. The engagement with this range of elements from within a course is aimed at creating better learning outcomes. As tertiary education moves to an increasing online and blended mode, it is imperative to investigate the role of online dialogue in enhancing learning outcomes and critical thinking in particular. Having said that, the role of online discussions can, and will differ in each course depending on the course design.

The importance of effectively teaching critical thinking to students has not been lost on the key regulatory stakeholders of Education. In the Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008), thinking has been identified as one of the essential skills for 21st century learners. In response, the recently developed Australian curriculum highlighted critical and creative thinking as a key general capability encompassing the knowledge, skills, behaviours, and dispositions of a critical and creative thinker and being able to apply them in a range of circumstances across all disciplines (ACARA, 2013). The Australian curriculum defines critical and creative thinking as the ability:

> to generate and evaluate knowledge, clarify concepts and ideas, seek possibilities, consider alternatives and solve problems. Critical and creative thinking are integral to activities that require students to think broadly and deeply using skills, behaviours and dispositions such as reason, logic, resourcefulness, imagination and innovation in all learning areas at school and in their lives beyond school. (ACARA, 2013, p. 66)

These documents governing standards for thinking in schools highlight the importance of empowering teachers with the ability to practice and impart these essential critical and higher-order thinking skills to their students. It is here that tertiary education plays a critical role; the teaching of skills needed for reflective and higher-order thinking, as well as the ability to teach these skills to students. Thus, Teacher Education programs must teach future educators how to think, not what to think (Bruning et al., 2004).

Engineers Australia's (2011) Competency Standards for Professional Engineers include the ability to apply engineering methods while developing solutions to complex problems and issues. They articulate many of the skills described by the researchers above as part of their professional standards. For example, Engineers need to be able to justify, apply, predict, evaluate, critically review, interpret, investigate etc. Interestingly, the Australian employability skills framework also includes the adaption and application of knowledge and the identifying, solving and anticipation of problems (Ithaca Group, 2012).

Within both teacher education and engineering education there is a requirement for graduates to gain the skills of critical and creative thinking. Much of the research in critical thinking seems to be generic, that is, presented in a manner that infers it across any discipline, or is limited to exploration within a specific discipline. Emerging from an exploration of critical thinking differentiation between disciplines, in this journal article we describe the investigation of how or if critical thinking is displayed differently within the online forums of an education and engineering undergraduate course.

Disciplinary differences

Universities are made up of different disciplines or academic tribes. Each tribe has a different culture, practice, knowledge, belief and form of communication (Becher, 1994). Becher went on to suggest that the different disciplines can be broadly clustered into four different areas:

- 'Hard-pure' disciplines such as Physics, Mathematics, and Chemistry; where knowledge is cumulative, simplified and results in discovery or explanation.
- 'Soft-pure' disciplines such as History, Philosophy, and Anthropology; where knowledge is holistic, concerned with particulars and results in understanding or interpretation.
- 'Hard-applied' disciplines such as Engineering, Dentistry, and Medicine; where knowledge is pragmatic, concerned with mastery of the physical environment and results in products or techniques.
- 'Soft-applied' disciplines such as Education, Law, and Social Sciences; where knowledge is functional, concerned with enhancement of practice and results in protocol or procedures.

Lueddeke (2003) commented that teaching in 'hard' disciplines is more likely to have a teacher-centred approach. The knowledge in these disciplines is often presented in a linear fashion and the student attention is on fact retention and solving structured problems. This is in contrast to the student-centred approach often found in 'soft' disciplines which are more dialogic in nature encouraging discussion and debate.

In this study, the engineering discipline would be considered 'hard-applied' where factual understanding is applied in different environments, and education would be considered 'soft-applied' where learning occurs iteratively and the "emphasis is on personal growth and intellectual breadth" (Lindblom-Ylänne, Trigwell, Nevgi, & Ashwin, 2006, p. 287). Although consideration must be given to discipline differences there are also a number of similarities. For example, both engineering and education programs have clear requirements from external accreditation bodies related to the discipline (e.g., Engineers Australia and Australian Institute for Teaching and School Leadership). These bodies have a significant impact on the content and processes within the discipline. Both tribes in this study are 'applied' disciplines, and as a study by Lindblom et al. (2006) revealed, there was no "significant differences in the approaches to teaching between 'pure' and 'applied'" (p. 294) irrespective of whether the disciplines was 'hard' or 'soft'. They went on to recommend that a way to improve "student learning is to support teachers in developing more student centred approaches to teaching" (Lindblom-Ylänne et al., 2006, p. 295) in all contexts.

This study provides the opportunity to explore the inter-relationship of how students in different disciplines use online forums to develop a broader knowledge community. Becher (1990) recommended that research in emerging areas of enquiry across disciplines (e.g., exploration of online discussion) within higher education can bring a depth of understanding to the academic enterprise (of online discussions); create interest and involvement; develop overarching concepts, to provide a range of interpretations, and increase collaborative research. In general, this study enables researchers "to bring together findings in different fields and to develop general theories which integrate them" (Becher, 1990, p. 345).

Conceptual framework

Initial research that explored online discussions simply investigated the social dimension of online postings. Henri (1992) expanded on this research by beginning to also examine the cognitive aspects of the online posts. Henri provided a framework to study posting types and to assist educators in guiding learners through the learning process. Table 1 provides this framework, which was used to guide the analysis of the online discussions in this research.

Henri's (1992) framework includes five dimensions:

- Participative: posts per individual, that is, the raw number of posts;
- Social: posts related to developing trust and learning community, unrelated to the content matter;
- Interactive: posts that respond to or comment on the postings of others;
- Cognitive: posts that support the learning process and include elements of understanding, reasoning, clarification, inference, judgement and strategizing. This dimension can be further broken down into surface and deep processing; and
- Metacognitive: posts related to the knowledge of how one learns (e.g., knowledge of self or the task and past successful strategies) and the skills related to effective learning (planning, regulating, evaluation and self-awareness).

Table 1
Henri's (1992) Content Analysis Model For Asynchronous Conferencing

Dimension	Definition	Example Indicators	Categories
Participative	Compilation of the number of messages or statements transmitted by one person	Number of message Number of statements	Overall Active participation in learning process
Social	Statements not related to formal content	Self-introduction Verbal support 'I'm feeling great.....'	Social
Interactive	Chain of connected messages	'In response to Celine....' 'As we said earlier ....' 'The problem under discussion....' 'I think that ....'	Explicit interaction Direct response/questioning Direct commentary Implicit interaction Indirect response Indirect commentary Independent statement
Cognitive	Statement exhibiting knowledge and skills related to the learning process	Asking questions Making inferences Clarifying concepts Referring to literature Formulating hypotheses Proposing solutions Making value judgements	Elementary clarification In-depth clarification Inference Judgement Strategies
Metacognitive	Statement related to general knowledge and skills and showing awareness, self-control, and self-regulation of learning	'I wonder...' 'I understand....' Comparing oneself to another Asking whether one's statement is true Predicting consequence of an action	Knowledge of self Knowledge of task Knowledge of strategies Evaluation Planning Regulation Self-awareness

This research is particularly interested in the cognitive and metacognitive levels, which represent the higher order thinking elements. As mentioned previously, cognitive posts can be further broken down into surface processing and in-depth processing where in-depth processing is more complex and rated as a higher level of thinking. Superficial posts are generalisations or unsubstantiated comments, whereas in-depth posts demonstrate high levels of clarification, interpretation, and inference; multiple perspectives, the linking of relationships between different ideas; and the defence of solutions.

Methodology

This project was exploratory in nature, using a naturalistic inquiry approach (Lincoln & Guba, 1985; Wellington, 2000) where the researcher and the methodology were non-controlling and non-manipulative. The inquiry involved "studying real-world situations as they unfold naturally" (Patton, 2002, p. 40); furthermore, the approach involved the researcher as part of the natural setting.

This research was developed after a conversation following an interdisciplinary meeting where colleagues in different faculties discussed the use of, and student response to, discussion forums in their courses. The researchers were interested in investigating this as a means to "deepen their understanding of their teaching practices and to improve the quality of student learning" (Stierer & Antoniou, 2004, p. 275). A case study reporting mode is used to describe the research and its outcomes. The two case studies

emerged from two courses in two faculties at a regional university in Queensland and describe the activities and students' participation in online discussion forums. Convenience sampling was used to select the courses, ensuring that instructors were interested in researching together. Both courses were at the undergraduate level early in the degree, had similar modes of offer, were from two different disciplines, and had no assessment expectation for online forum participation. Courses from the engineering and education faculties were used. In both cases the instructors were also part of the research team. This dual case study uses the same data collection and analysis across both cases to compare and contrast results between the cases (Herriott & Firestone, 1983; Stark & Torrance, 2005).

The following research questions were developed for the study:

1. Do students from different disciplines display different levels of thinking?
2. If there is an apparent difference, what are the incidences of the different levels of thinking in each discipline?

Engineering context

The engineering statics course that was explored in this study is a first year, second semester, engineering course that is traditionally 'problematic' for students. It was a highly numerical course that introduces students to fundamental engineering theoretical concepts for the first time in their program. The course is taken by a wide variety of students undertaking 2, 3 and 4 year engineering programs in the disciplines of civil, mechanical, environmental, and agricultural engineering. Students study both on campus (i.e., approximately 25% of the class), incorporating both face to face and online elements, and as distance students (i.e., approximately 75% of the class), which is fully online.

All students have access to the course learning management system (LMS) and are encouraged by the instructor to use it for questioning and clarification of the course material. Discussion forums were specifically linked to modules and activities within the course but were not seeded with discussion questions by the instructor. Course guidelines encourage the use of these forums for exploring and discussing the course material. All discussions threads were initiated by students and responses were given by both student peers and course staff.

Students were not required to post in the forums and postings did not contribute to final grading. However, the forums provided the only opportunity for distance students to discuss the course material with student peers and assessment and were, for the majority of students, the only means of interaction with peers and staff. This course tends to generate a relatively high level of discussion on the forums when compared to other engineering courses.

Education context

The course within the teacher education context was a second year course within the 4 year programme, or the first semester of a 1 year graduate diploma program within the secondary specialisation program. The course had three key focuses: firstly, investigating issues for middle years learners that may lead to disengagement; secondly, exploring pedagogical approaches for students in the middle years; and thirdly; planning for contemporary curriculum, pedagogy, and assessment in the middle years.

The course was offered on campus in a blended mode and also in fully online mode. The course had 104 students enrolled and was designed from a constructivist perspective. Ongoing interaction and dialogue between students was encouraged by the instructor; however, it did not form part of the assessment of the course. The online forums were pre-populated with questions or activities by the instructor but also provided the opportunity for students to start new threads.

Data and data analysis

Base data was extracted from the archives of online discussion forums in each course. Online discussions were analysed to identify the incidences of social, cognitive, and metacognitive posts within online discussions using Henri's (1992) content analysis Model for Asynchronous Conferencing (see Table 1). Henri's (1992) model aligned with a cognitive approach to learning and has provided educators and

researchers with a tool to understand and "highlight five dimensions of the learning process exteriorized in messages" (Henri, 1992, p. 117).

After course results were released at the end of the semester, the data was de-identified by a research assistant not related to either course and then analysed by the research team. The unit of analysis was deemed to be each post where the author of the post, rather than the researcher, decided on the content and the length of the post (Weltzer-Ward, 2011). If posts could be coded to more than one category then it was coded up to the highest level. To enhance reliability and validity of the results the data was analysed independently (after an initial discussion and coding training). The researchers then reconvened to compare the coding of a larger number of posts. It was noted that the content knowledge of the discipline impacted on the level at which posts were coded. When the coder was also the subject matter expert they could identify critical thinking within the discipline more readily than someone with less or no discipline knowledge. Overall, the majority of coding was at the same level and when it differed the Engineering case was coded up to a higher level, particularly at the differentiation between interactive and surface cognitive levels. There was no disagreement at other coding levels.

Findings and discussion

The researchers wanted to identify if there was any difference in the level of online engagement between the two disciplines. One of the immediate differences between the two disciplines was the percentage of students who never posted during the semester. Figure 1 indicates the raw number of posts per student per course. Despite posts in both courses being voluntary (i.e., not assessable), 60% of engineering students never posted, whereas in contrast the education discipline had a 94% participation rate.

Such a high percentage of lurking or vicarious learning from the engineering students when compared to the education students was not a surprise to the engineering academic, as within this subject students' participation online tends to be for question and answer posts and responses, largely because there is only one answer to students' questions and the material does not lend itself to discursive exploration or require resources additional to study materials provided. This aligns with the findings of Clay (2010) who found that engineering students' online communication is infrequent and they are "pragmatic and required identified aims before electing to participate" (p. 3). The concept of lurking is not new and it remains widespread. Students who lurk or are not visible in online discussion are not necessarily compromising their learning outcomes (Ebner & Holzinger, 2005). However, silence on the discussion forums does not lead to effective collaborative or community learning.

Online discussion in the education forums included debate, sharing of experiences and resources, and the collection of a range of perspectives on the issue under discussion. Within the education context there is rarely one answer to a question and students gain a range of ideas through discussion, which might assist them to resolve issues in an unfamiliar context. In addition, those forums in which the instructor created a question or activity to which students could respond had higher levels of interactivity.

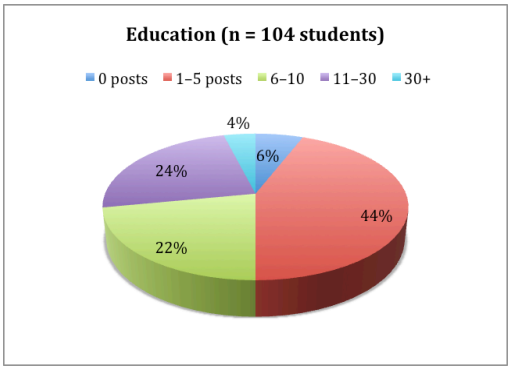

Figure 1. The number of posts per student over a 15-week semester, Education

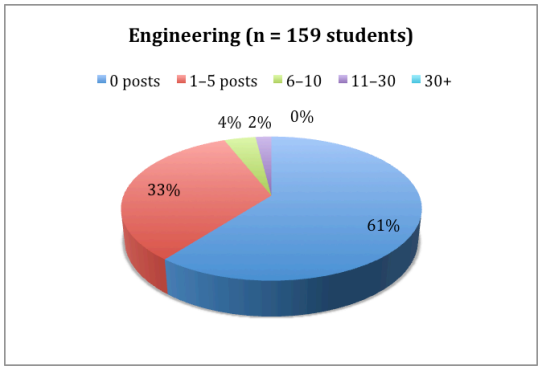

Figure 2. The number of posts per student over a 15-week semester, Engineering

As data in Figures 1 and 2 indicates, the number of students who posted more than 10 times was much greater in education (28%) when compared with engineering (3%). In both disciplines, very few students had posted more than 30 times over the 15 week semester. The 98 (of the 104) education students who participated in the online discussions posted 891 posts, or an average of 9 posts per student. In contrast, the participation of the 63 (out of 159) engineering students who posted resulted in 264 posts, or an average of 4 posts per student over the semester. Overall, in both disciplines, there was a low level of posting by students. It was noted by the researchers that not only were the number of posts higher in education but also the lengths of the posts were much longer when compared with the engineering posts. Possible causes of this differentiation is the fact that engineering is considered a 'hard' discipline compared to education which is considered a 'soft' discipline. In education, communication is a key aspect of the learning process, the learning outcomes, and the professional expectations of the program, and students are expected to contextualise their comments. Having said that, both disciplines are applied disciplines rather than 'pure' or theoretical disciplines. Perhaps there is also a hierarchy of the disciplines or content expectations that impact on the number of posts.

The engineering students were in their first year of online study and they may have felt communication anxiety (Feenberg, 1987) or "ecoshock" (Fontaine, 2000; San Jose & Kelleher, 2009) resulting in low levels of posting due to their minimal experience as online learners. Ecoshock occurs when there are changes in psychological, physical, technical, and biological environments (Fontaine, 2000). As described by San Jose & Kelleher (2009), "the ecoshock concept encompasses the difficulties and challenges individuals experience when they are looking to use emerging communication technologies" (p. 471). Being unfamiliar with the online space can impact on student confidence to post in online spaces; if they are uncertain how to behave in the online discussion, their unfamiliarity may result in their lurking rather than in their active participation.

Figures 3 and 4 present an analysis of the student posts using Henri's Content Analysis model. To provide a more in-depth analysis, the cognitive level of posts has been further broken down into either surface processing or deep processing. Henri (1992) suggested that distinguishing between surface and the more complex in-depth processing "makes it possible to identify the skills link to critical reasoning and then to evaluate the level of information processing applied by learners" (p. 131).

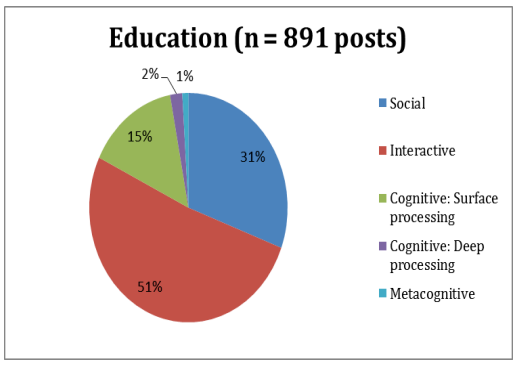

Figure 3. Analysis of Education posts using Henri's framework

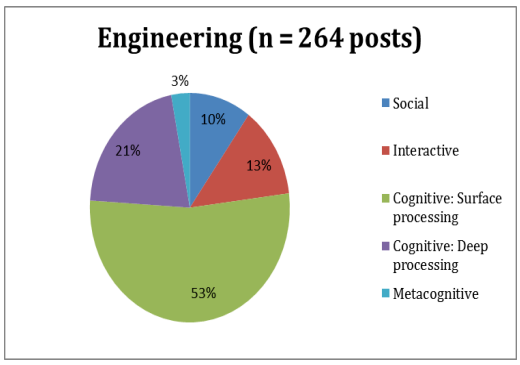

Figure 4. Analysis of Engineering posts using Henri's framework

Of the 891 posts created by the 98 active participants in the education discipline, over half (52%) were categorised as interactive, and did not include high levels of critical thinking. The next most common type of post in education was social (31%). Although the students were highly active in the online discussions, they posted at superficial levels. In contrast, the highest number of postings for the engineers was at the cognitive levels, with surface processing at 53% and in-depth processing at 21%. Even accounting for the discrepancy between the coding of interactive and surface cognitive posts mentioned previously, the engineering course had a much higher number of posts at the surface cognitive level compared to education. The same can be said for the deep cognitive processing level. This was a surprising result for the researchers given the nature of the engineering content and the role of the forums.

The difference may be the result of discipline difference or the differences in the types of students each discipline attracts.

The engineering social posts appeared only in week 1, where they were introducing themselves to one another, whereas the education students had social posts scattered throughout the semester and used these posts to motivate or support their peers. Perhaps this could be attributed to a discipline difference, where the nurturing role of the educator is to encourage and support others along the learning journey (Noddings, 2012). The quantity and supportive nature of the education posts versus the pragmatic nature of the engineering posts seems consistent with disciplinary cultures (Becher, 1994).

Another difference was that the engineering students largely participated in a single post/response cycle whereas the education students had multiple responses to an initial post. This could be attributed to the fact that in the education course, the instructor pre-populated the forums with questions and activities and also the fact that education as a humanities discipline is largely dialogical (Arnett, 1997) while the engineering discipline is far less so.

In both cases, very few students posted at a metacognitive level, perhaps because the course designs in both disciplines did not require them to do so. They used the online discussion space to get to know their peers and to respond to instructor and peer questions rather than to share their metacognitive knowledge and skills with others. That is, they did not discuss their thinking and learning processes; they just discussed the end product of their learning. It should not be unexpected that there were low levels of deep processing and metacognition in the students' online discussions. Archer (2010) reminded us that students are more likely to make their deep processing visible within their assessment responses rather than in online discussion responses. If the only place we look for higher levels of thinking is in online discussions, we are looking in the "wrong place" (Archer, 2010, p. 69).

Because both disciplines are 'applied' disciplines, the culture of the academic disciplines may have little to do with the differentiation on the outcomes described above. Interestingly, Lindblom et al. (2006) had posited "that the same teacher in different contexts may adopt a different approach to teaching" (p. 296). If the same study was completed with the same instructors but in different courses, the results may not have been the same as these. Alternatively, differences could occur due to the pedagogical approach taken by the instructors or the nature of the course content in those specific courses.

Irrespective of discipline, a number of common themes appeared within the online discussions. Not surprisingly perhaps, assessment was a key topic of discussion as was process orientated questions, (e.g., How do I access…). Within the engineering discipline there was more discussion that was content based when compared with the education forums; largely to do with how to answer the mathematical questions. This is an interesting finding, since the education forums were seeded, by the instructor, with content-based activities and questions.

The engineering course outcomes and content were focused on acquiring skills for problem solving. Students were learning to solve well defined, albeit complex, problems and to link ideas for enhanced conceptual understanding, demonstrating Halpern's (2003) purposeful, goal directed thinking. However, for the purposes of this course students were not expected to think across disciplines in order to solve messy, unstructured problems. So, by the definition provided by Bruning et al. (2004), the engineering students were being asked to acquire and demonstrate problem solving thinking rather than critical thinking. In contrast, education students were dealing with much more open ended problems and were able to explore them through the sharing of opinion and experience. Bruning et al. (2004) suggested that it is in fact these types of problems where critical thinking is most important.

The engineering students were not being asked to work collaboratively or to develop a learning community; indeed, the expectation is that most learning in this type of course would occur as a result of individual effort. The course material is not suited to dialectic or experiential learning, so student aims in online participation were mostly for the verification of their own understanding, developed through individual interaction with course materials, or for administrative clarification, aligning with Clay's (2010) findings about the 'pragmatic' online participation of engineering students.

Research outcomes and implications

This study has provided the researchers with an opportunity to extend their research context beyond their individual disciplines and enable useful comparisons and contrasts to occur. Becher (1994) suggested that "this encourages other researchers to draw wider conclusions from their work than the evidence should allow" (p. 159).

As institutions of higher education increase the number of courses they offer online, their instructors in all disciplines will need to adjust to their new roles as online designers and facilitators. Students will also need to adjust how they learn online to ensure they make the most of the learning opportunities made available to them. A number of implications emerged from this study related to the effect of online teaching and learning on improved learning outcomes.

Firstly, novice online educators often perceive the online learning environment as a space to upload content and create empty discussion forums. Where online discussion is to be promoted as a learning tool for a particular course, then forums should be populated with questions or activities to encourage engagement and interaction. In addition, those activities or questions should elicit a range of different responses and promote critical thinking. For example, asking students to share their experiences will elicit a range of responses but may not promote critical thinking. The questions or activities should result in students having to link facts, ideas, and perspectives to interpret, infer, propose and judge. Students should be taught how to analyse, synthesise, and evaluate and then required to demonstrate their abilities in these higher order processes.

Secondly, creating online discussions will not necessarily promote visible learning. Relating the online discussion posts directly or indirectly to assessment is likely to increase the interaction and engagement within the online discussion forums. This, in turn, will make visible the students' thinking and learning. The goal is to increase the number of students who are 'workers' and to reduce the number of 'shirkers' and 'lurkers' within a community of learners. When students neglect to post, their learning is invisible until the submission of assessment. Without visibility, the instructor is unable to diagnose misconceptions, assist learners in moving beyond their initial beliefs and/or enhance their learning outcomes. "[T]he focus is always on what the learner is actually doing: placing the learning and teaching activities at the heart of the process" (Mayes & de Freitas, 2004, p. 6). This is related to the first implication for online forums: to become an effective learning tool they require effective learning design and facilitation. It may also be necessary to complete research to investigate why it is that students 'lurk' or 'shirk' within their online courses.

Finally, online students need to feel comfortable sharing online, not just their experiences and perspectives but also their learning processes. As students complete more online courses or are involved in more blended learning environments, they will feel less "ecoshocked" and their perceived isolation and unfamiliarity within the online space will be reduced and their confidence within the online space enhanced. Higher education institutions in general and individual courses in particular should implement intervention strategies to alleviate the effects of ecoshock (San Jose & Kelleher, 2009).

Conclusion

In terms of the research questions, the nature of the discipline or the content of the course did impact on the students' display of levels of thinking and also the number of posts overall. The education students posted more often and had longer posts when compared with the engineering students. While the engineering posts demonstrated higher levels of thinking, the education students were more social and interactive.

Results from this study are limited to the two courses under investigation within a regional university and cannot be broadly generalised to other education or engineering courses or other disciplines. The conclusions drawn would be strengthened by replicating the study in other courses at the same and other higher education institutions across the same and different disciplines in future studies. Another rich area for further work would be the investigation and definition of circumstances under which online discussion should be promoted as a key means of engagement and when other engagement, such as individual activities, is appropriate.

Discussion forums have both potential and limitation in their ability to support deep learning and thinking. It is neither the technology itself, nor the method of teaching by itself that will enhance student learning; "It is far more important to know how to use the instructional methods and technology to support learning outcomes that are integrally linked to the student learner as a critical, practical, and creative thinker" (Blouin et al., 2009, p. 9). This will improve the outcomes of higher education and provide opportunities for students to gain skills and knowledge required in today's workplace.

With the movement to online teaching and learning, attention should be given to the enhancement of learners' online engagement and the visibility of their critical thinking. The increased use of discussion forums as the key communication between peers and instructors enhanced the importance of exploring their use in courses and to discuss the design and facilitation of these forums to enhance learning. Within a 21st century learning community, students need to be convinced that 'we is better than me' and that they should actively engage with their peers in online discussion as a means of making meaning and improving the learning outcomes for all participants.

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