MAKING CONNECTIONS BETWEEN DIFFERENT DISCIPLINES THROUGH THE LENS OF COGNITIVE PRESENCE

ABSTRACT

Online discussion forums are a common element of teaching and learning within higher education institutions. Effective teaching presence is required to ensure that active online interaction encourages learners to continually share, question, debate, justify and consider multiple perspectives/solutions rather than to take a passive role. This paper investigates connections between disciplines in the use of asynchronous online discussion forums to deepen discipline knowledge. By crossing the divide between the mathematics and teacher education disciplines this paper compares and contrasts how these varied disciplines explore meaning-making within their undergraduate discussion forums. Data from undergraduate discussion forums are analysed for cognitive presence using Garrison, Anderson and Archer's (2000) Community of Inquiry model. One outcome from this study is that discipline matters but teaching presence matters more.

INTRODUCTION

There are an increasing number of online and blended courses in higher education. Akyol, Garrison and Ozden (2009) stated that there is consequently a "need to explore and develop frameworks or models in order to understand the complex nature of teaching and learning in their learning environments" (p. 1834). The Community of Inquiry model developed by Garrison, Anderson and Archer (2000) is one such framework that has been developed for educators and researchers to explore the dynamics and complexities of online and blended learning environments.

Technology has had an impact on teaching and learning in all educational contexts. Boud and Prosser (2002) suggested that improved learning requires educators to explore and respond to “the quality of students’ experience using technologies” (p. 237). We need to look beyond the technology to the pedagogy, design and delivery of the learning experience (Ladyshewsky, 2004). It is not about the technology but how the educator uses the technology. The introduction of online discussions may not impact on learning. However, what can make an impact are the pedagogical choices made by the educator regarding how the online discussion might be used to promote socially constructed knowledge within higher education.

TECHNOLOGY AND CHANGES IN TEACHING IN HIGHER EDUCATION

Higher Education institutions are no longer bound by the traditional teaching approach of lecture and tutorial which are time and place dependant. At the World Economic Forum, Twomey (2009) reported that “[e]ducation is in a state of transition from a traditional model to one where technology plays an integral role. However, technology has not yet transformed education” (p. 48). The rapid and continuous evolution of technology tools and access to information mean that the *www* will continue to enable learning *wherever, whenever* and for *whomever*. Increased internet access, open content repositories, social networking services, and online collaborative tools provide multiple ways of communicating and gaining information. Universities are now embracing these virtual learning resources to provide flexibility in the ways that learners access academic experts, other learners and “scholarly and research material” (Bradwell, 2009, p. 11).

Increased access provides opportunities for increased engagement and interaction. Twomey (2009) reminds us that “the technology to propel educational achievement can only be value-added if linked with creative pedagogy to educate students with 21st-Century skills and to train teachers to engage actively with students in interactive learning communities” (p. 48). Online learning has “the potential to bring students together and engage them collaboratively in purposeful and meaningful discourse through the creation of sustainable communities of learners” (Garrison, 2009, p. 97). Boud and Prosser (2002) suggested that in an online environment, educators need to develop pedagogical approaches that promote interaction by focusing on “engaging learners, acknowledging the learning content; challenging learners and providing practice” (p 240-241). They go on to comment that for learners to engage meaningfully they “need to experience a challenge and respond to it, not just be the recipient of an information transfer” (Boud & Prosser, 2002, p. 243). Challenge is enhanced through instructional design and pedagogies which scaffold the learners to question their prior experiences and promote deep discipline knowledge.

SCAFFOLDING TO PROMOTE IMPROVED LEARNING OUTCOMES

Analogous with building construction, cognitive scaffolding implies that support is provided to learners and as progress is made in knowledge construction the assistance is gradually reduced until learners achieve independence (Wood, Bruner & Ross, 1976). Holton and Clarke (2006) “define scaffolding to be an act of teaching that (i) supports the immediate construction of knowledge by the learner; and (ii) provides the basis for the future independent learning of the individual" (p.131). Scaffolding can take on different forms ranging from simply using the right word or question; to the provision of tasks, resources or devices; to engaging learners in conceptual discourse (Anghileri, 2006; Holton & Clarke, 2006). Unguided or minimally guided discovery has limited success for novice learners and in fact there is "compelling evidence that more strongly guided methods that involve demonstrations of problem solving strategies accompanied by hands on practice exercises with authentic problems and immediate feedback on mistakes are necessary to maximize the learning of most students" (Clark, 2009, p. 6). In a computer-based learning environment scaffolding can be achieved by providing well structured learning tasks, and may include static questions, dynamic support sensitive to the needs of individual learners or computer-based tools to guide the thinking of learners (Azevedo & Hadwin, 2005).

Our expectation is that educators can provide learning experiences and facilitation of online discussion to promote learners moving from surface learning, which normally produces short term outcomes to a deeper understanding. Henri (1989) revealed that deep learning "is accomplished only when the learners translate newly-acquired information into their own terms, connecting it, for example, with their lived experience" (p. 130). This requires educators to encourage learners to continually share, question, debate, justify and consider multiple perspectives/solutions rather than to take a passive role in their learning.

When learners connect with others through technology, they create networks for and of learning. In the connectivism theory Siemens (2005) considers learning as actionable knowledge which may be attained through experience. However, this knowledge is strengthened through thinking, sharing and reflecting, all of which are key elements in the two case studies explored in this study.

This paper investigates connections within and between disciplines in the use of asynchronous online discussion forums to deepen discipline knowledge. Within this virtual space learners investigate problems, explore and share possible solutions and reflect on processes. The online discussion forums are used to connect learners to the lecturer, their peers and the content. The Community of Inquiry model provides the framework for analysing the level of cognition in online posts. By crossing the divide between mathematics and teacher education disciplines this paper will compare and contrast how these varied disciplines explore meaning-making and connect theory and practice within their undergraduate online learning communities.

COMMUNITY OF INQUIRY

Garrison, Anderson and Archer's (2000) Community of Inquiry model was developed to "articulate the behaviours and processes required to nurture knowledge construction through the cultivation of various forms of 'presence'" (Shea & Bidjerano, 2009, p. 544). Arbaugh, Cleveland-Innes, Diaz, Garrison, Ice, Richardson & Swan (2008) reminded us that the Community of Inquiry framework provides "a collaborative-constructivist perspective to understanding the dynamics of an online learning experience" (p. 133-134). The Community of Inquiry values the concepts which parallel the general aims of higher education, including critical thinking, reflection, and discourse.

There are three key presences within the Community of Inquiry framework: social presence, teaching presence and cognitive presence. Figure 1 shows how each of these elements intersect.

- Social presence is defined by Garrison, Anderson and Archer (2000) as “the ability of participants in a community of inquiry to project themes socially and emotionally, as ‘real’ people” (p. 94).
- Cognitive presence is concerned with the “construction of meaning and confirmation of understanding” (Garrison, Cleveland-Innes & Fung, 2004, p. 63).
- Teaching presence is “the design, facilitation and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes” (Anderson, Rourke, Garrison & Archer, 2001, p. 5).

INSERT FIGURE 1 ABOUT HERE

These three presences do not necessarily occur independently of one another as all contribute to the educational experience of learners in a semester course of study. In order to develop higher order thinking skills (cognitive presence) and collaboration in asynchronous online discussion forums, commitment and participation (social presence) are required (Garrison et al., 2000). To ensure that students move through the phases of cognitive presence effectively, teaching presence provides the necessary guidance (Shea & Bidjerano, 2009). Teaching presence balances cognitive and social issues, facilitating discourse and direct instruction (Garrison & Arbaugh, 2007). With an appropriate mix of all three presences, the online asynchronous discussion forum can lead to “fruitful critical inquiry” (Garrison et al., 2000, p. 96).

The primary concern of this paper is with the cognitive presence element. “Cognitive presence is reflective of the purposeful nature of collaborative knowledge construction inherent in constructivist educational experiences” (Arbaugh, Cleveland-Innes, Diaz, Garrison, Ice, Richardson & Swan, 2008, p. 134). Cognitive presence can be partitioned into four phases:

- Triggering: This is the point at which a problem/issue is conceptualized or realized. Learners feel a sense of dissonance.
- Exploration: During this phase learners search for information and ideas (both experiential and through literature) to clarify/make sense of the problem or issue.
- Integration: This is the “connecting of relevant ideas capable of providing insight into the dilemma” (Garrison, Anderson & Archer, 2001, p.15). Learners begin to construct tentative solutions to the initial problem or issue.
- Resolution: This final phase is where learners commit to a solution, testing either vicariously or in an authentic context.

Table 1 indicates the phases, descriptors and indicators of cognitive presence.

INSERT TABLE 1 ABOUT HERE

Cognitive presence concerns the construction of meaning and confirmation of understanding. Akyol, Arbaugh, Cleveland-Innes, Garrison, Ice, Richardson & Swan (2009) commented that cognitive presence "includes understanding an issue or problem; searching for relevant information, connecting and integrating information; actively confirming the understanding in a collaborative and reflective process" (p. 125). The four phases of cognitive presence will be used to inform the analysis of online discussions within two discipline areas.

METHOD

Within this paper case study method is used to investigate the connections between undergraduate mathematics and education learners' use of online discussion forums. Merriam (1998) suggested that the benefits of using case study "is in the process, rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation" (p. 19).

The research questions for this study are:

- To what extent are the phases of cognitive presence developed within asynchronous online discussions?
- How does the use of asynchronous online discussion forums in undergraduate education and mathematics compare and contrast?

The two case studies below describe the learning activities within two different discipline contexts in a regional Australian university. The role of the online discussion forum in both cases was to promote deep learning using the principles of social constructivism. The collaborative learning experiences were designed to assist learners in meaning-making at both the individual and group level through critical and reflective dialogue focusing on a specific issue or problem.

The education case study

Within a teacher education course learners engaged in an online collaborative project. Within a structured environment the learners investigated authentic issues of teaching and learning within 21st century classrooms (e.g., pedagogical approaches to decrease cyberbullying, and enhancing the learning outcomes of second language learners and autistic learners). The learning experience was a blended one in that the course was in face-to-face mode; however the majority of the activities related to this learning experience were conducted online. This project enabled the learners to engage with peers, practising teachers and academics. The cohort was in the second year of their four year education program. These learners had no or very limited previous online learning experiences. Participation within this project was assessed by learners self selecting and submitting what they perceived to be their best quality postings throughout the structured experience.

The mathematics case study

After being provided with information about the aims and mechanics of successful group work, distance learners in a core first year mathematics course were divided into groups of 25-30 to participate in collaborative problem solving in asynchronous discussion forums. Learners were provided with a series of five non-routine problems at two week intervals across the semester. Mirroring the oncampus face-to-face experience (see Taylor & McDonald, 2007), discussion of a problem was scaffolded by educator initiated forum threads of aim, method, working and conclusion, based on Polya's (1957) heuristic for the problem solving process (understanding the problem, devising a plan, carrying out the plan and looking back). Learners were required to participate in online discussions as part of their assessment however they were not evaluated on the quality of their postings.

The structure and processes of the educational experience in both contexts was designed to scaffold the learners. Until the writing of this paper however, the educators (who are also the researchers) were unaware that their instructional design intuitively matched the four phases of cognitive presence. Table 2 presents the learning activities and their relation to the phases of cognitive presence for each case.

INSERT TABLE 2 ABOUT HERE

The archives from online discussion forums in each course form the base data for analysis. The forum posts selected for analysis were from a five to six week period following the establishment of social presence and familiarity with the online interface within each group of learners. Content analysis of the postings was conducted using the four phases of cognitive presence indicated in Table 1: Triggering, Exploration, Integration and Resolution. An additional category was added: No category detected, where no cognitive presence could be identified or the posting was unrelated to the purpose of the forum.

A single message/posting is used as the unit of analysis. Where there were two possible phases present in a message, the message was coded up to the higher level in the hierarchy of phases. Each author independently coded all postings. To improve validity and reliability where there was disagreement between coders, negotiation and discussion of coding occurred until a consensus was reached (Garrison, Cleveland-Innes, Koole, & Kappelman, 2006).

FINDINGS AND DISCUSSION

The next section of this paper discusses the findings presented in Table 3 which indicates the number and percentages of postings within each phase of cognitive presence within each case.

INSERT TABLE 3 ABOUT HERE

A chi-square test of independence was used to determine if there were any differences in the distributions of cognitive presence categories within the course online forums for the disciplines. The analysis supported the assertion that there is a difference in the distributions of categories of cognitive presence (chi-square = 22.839, $p < 0.001$) with the mathematics forum containing more than expected integration posts (standardised residual 2.1) and the education forum containing more than expected exploration posts (standardised residual 2.0) as indicated in Figure 2.

INSERT FIGURE 2 ABOUT HERE

The following discussion will compare and contrast the relative frequency of posts at each phase for the cases. The results will be compared with those found in other published studies.

Triggering phase. In both disciplines a triggering event was initially provided by the instructor, e.g. mathematical problem posed, controversial reading provided. There is little difference between the disciplines within the learners' posts at the triggering phase, with education having 8% and mathematics having 14% of their postings at this level. Other researchers have also found that this initial phase which is used to stimulate the following three phases has a low percentage of posts (Garrison, Anderson & Archer, 2001; Kanuka, Rourke & Laflamme, 2007; McKlin, Harmon, Evans & Jones, 2002; and Redmond & Mander, 2006).

Exploration phase. As can be expected the exploration phase, which is characterised by broad searches for information which might assist in finding solutions for the initial dilemma, had the largest number of posts in both disciplines with education having 56% and mathematics having 39%. This result aligns with other research which has found similarly high percentages at the exploration phase (Garrison, Anderson & Archer, 2001; Kanuka, Rourke & Laflamme, 2007; & McKlin, Harmon, Evans & Jones, 2002; Redmond & Mander, 2007).

Within the education context, learners' posts in this phase included personal narratives, sharing of literature and questions of clarification. A reason for an increased percentage of posts in this phase when compared with mathematics may be due to the fact that in education there is a larger range of possible suggestions/opinions and there is rarely one right answer.

The exploration phase within the mathematics context was actioned by learners exploring a range of methods. In their search for a solution they were encouraged to seek multiple methods to solve the problem. Although there are multiple methods to solve the problem, the number of posts may have been confined because they were required to arrive at one solution.

Integration phase. There are significantly more posts in mathematics compared with education in the integration phase, with education having 14% and mathematics having 35%. A result of 14% is disappointing in the education context where you would hope that learners draw from multiple perspectives and sources of information to derive their best practice. The percentage of integration posts in mathematics is noticeably higher than the findings of other researchers (Garrison, Anderson & Archer, 2001; Kanuka, Rourke & Laflamme, 2007; McKlin, Harmon, Evans & Jones, 2002; and Redmond & Mander, 2007).

This higher percentage of integration posts in mathematics could be linked with the discipline expectations or the design of the activity. During this phase the mathematics learners were finding/designing their own solution using information and ideas gathered from the posts in the exploration phase. The process of finding a solution required them to integrate ideas from sources such as their peers' posts, the text and other sources. Garrison and Arbaugh (2007) indicated that many researchers have found that using the evidence made visible through online discussions, many learners have "great difficulty moving beyond the information exchange or exploration phase" (p. 162). This does not seem to be the case for the mathematics discipline, perhaps because there is a defined answer.

Resolution phase. At the resolution phase education had a substantially higher rate of postings (18%) than the mathematics context (3%). The mathematics outcome more closely aligns with previous research where the percentages ranged from less than 1% (Redmond & Mander, 2007) to 10% (Kanuka, Rourke & Laflamme, 2007).

The cognitive presence process involves "actively confirming the understanding in a collaborative and reflective process" (Akyol et. al., 2009, p. 125). As such, when coding resolution in the education context posts, the researchers included posts of a reflective nature. These posts may not have resolved the issue nor defended their possible solutions, however they did reflect on the changing nature of the learners' knowledge and future actions in addition to reflecting on the learning process during this time. This is possibly why the percentage of posts at the resolution phase was higher in education than in mathematics.

Within the mathematics context the resolution phase was deemed to have been the process of learners looking back and checking they have done what they were asked to do. It goes beyond stating the numerical answer to the question as the learners were required to link their answer and conclusion back to the aim and context of the initial problem. An explanation of why the small number of resolution posts in the mathematics context could be that once someone had posted a solution and conclusion there was minimal need for further discussion.

IMPLICATIONS

The differences in distributions of cognitive presence phases reflect the differences in the nature of the tasks set for discussion in the different contexts. In the mathematics context, problem solving involves a considerable amount of integration of ideas in order to arrive at the solution to the problem to reach resolution, whereas in the education context the emphasis is on exploration and debate to reach resolution. Through effective teaching presence the purposeful design and facilitation of learning experiences should provide opportunity for the learners to reach higher cognitive engagement.

The decisions on coding of posts at any particularly level can only be made on what learners make visible. What learners post does not necessarily represent their private thought processes; it simply represents what they are willing to make public. The cognitive presence phases provide us with a framework to view interactions and consider how we might improve them, at the individual and group level. Educators are able to use this information to review and modify their teaching presence, in particular instructional design, scaffolding and facilitation.

The cognitive presence indicators of the final phase of resolution do not currently include a reflective indicator. Perhaps adding this indicator in the resolution phase may go some way to providing data on learners' metacognition or promoting metacognitive activities by the learners. Learners are often asked to reflect on the learning and the learning process and this will provide coders using the cognitive presence element with an opportunity to explicitly situate these types of postings.

One limitation of this study is that the data was collected from a short segment of the semester. An analysis of discussion postings across a whole semester may result in a different distribution over the phases of cognitive presence. In addition, other artefacts such as assessment responses could provide another source of data. It is likely that learners would operate at a higher level of cognition where their efforts contribute to their final result. As with any case study, results are unable to be generalised. This case study was restricted to one institution, two disciplines and two educators. However, insights gained by the connections established and the professional conversations between the educators from different disciplines has proved useful in broadening reflections on teaching practice to develop deep discipline knowledge.

CONCLUSION

The focus of this study was to investigate the quality of cognitive presence within the two different disciplines of education and mathematics within undergraduate online discussions. This study found that when comparing different disciplines, context does make a difference. However teaching presence in the form of course design, scaffolding of learning activities and facilitation of online discussion makes more of a difference on the development of cognitive presence.

It is difficult to look at cognitive presence without considering the impact of teaching presence (and also social presence) on the learning outcomes and the use of online discussion to encourage the development of deep discipline knowledge. By working with educators in other disciplines and contexts we are better able to assist ourselves and our learners to become effective contributors to cognitive presence in the online asynchronous learning environment. The lens of the Community of Inquiry framework bridged the perceived divide between two diverse disciplines creating connections between two academics opening the pathway to future productive conversations about improving teaching and learning.

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Figure 1

Community of Inquiry

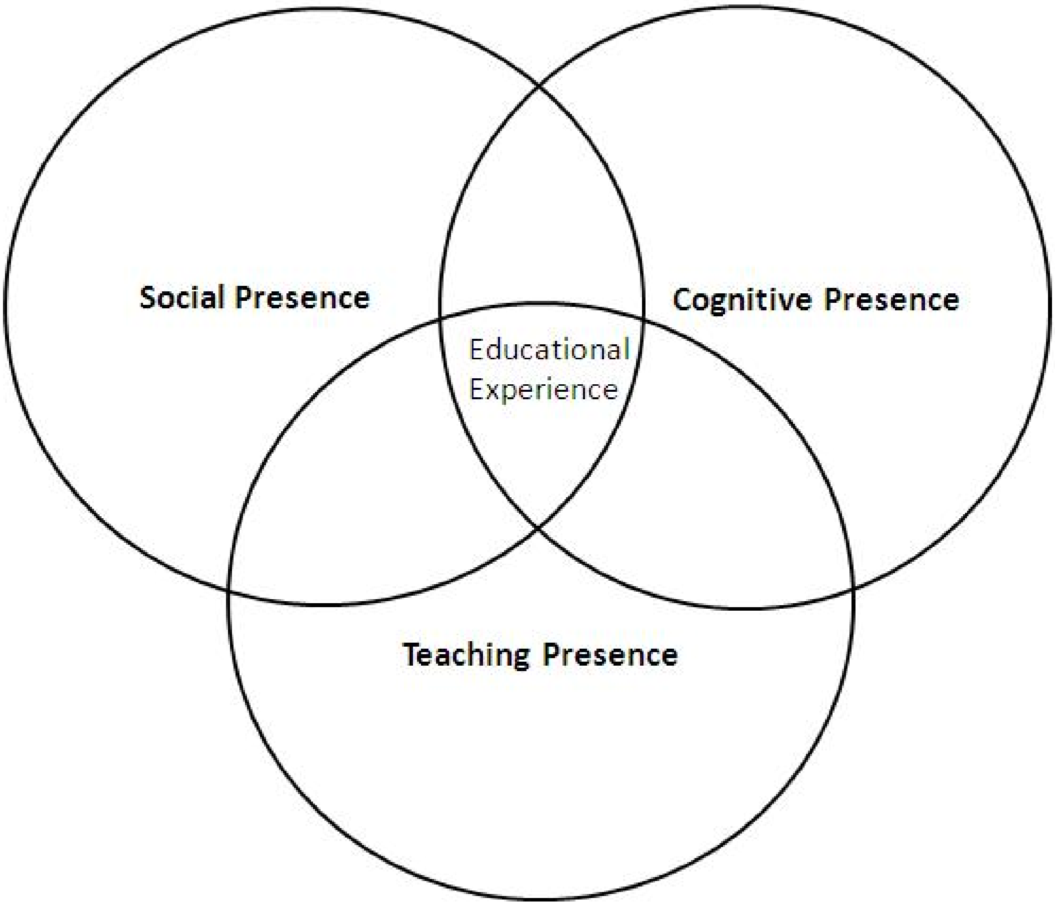

Figure 1. Community of Inquiry, (Garrison and Anderson, 2003).

Figure 2

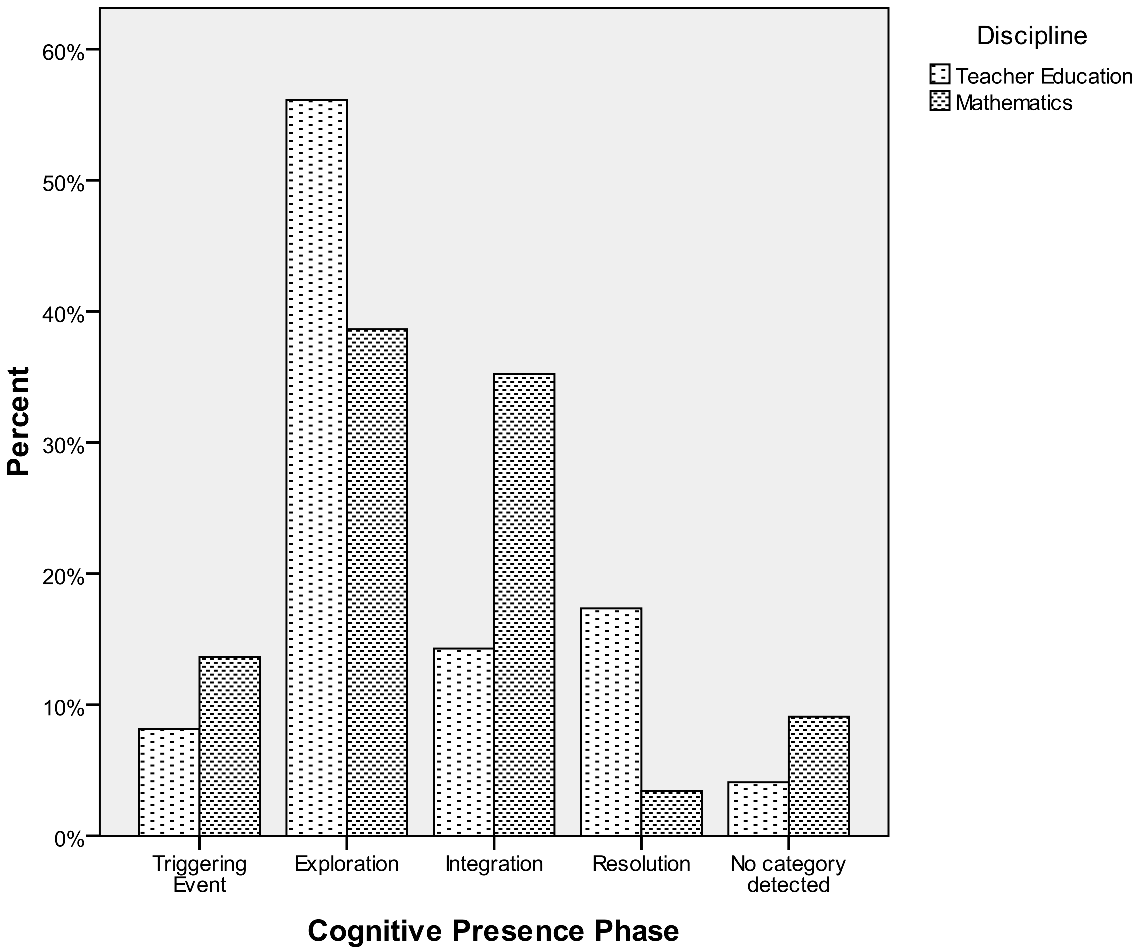

Figure 2: A comparison of the number cognitive presence postings by phase and discipline.

Table 1

Phase	Descriptor	Indicator
Triggering event	Evocative (inductive)	Recognize problem Puzzlement
Exploration	Inquisitive (divergent)	Divergence Information exchange Suggestions Brainstorming Intuitive leaps
Integration	Tentative (convergent)	Convergence Synthesis Solutions
Resolution	Committed (deductive)	Apply Test Defend

Table 1. Cognitive Presence descriptors and indicators (Garrison & Anderson, 2003, p. 61)

Table 2

Phases	**Education context: activity stages**	**Mathematics context: activity stages**
Trigger	Stage 1: Stimulus reading was provided to the learners. The stimulus material created a sense of dissonance where the learners began to see the issues or problems related to teaching in a digital and diverse classroom.	Aim: A non-routine mathematical problem was provided to the learners. The learners then presented ideas for what was needed to be achieved and in so doing gained an understanding of what the problem was really asking.
Exploration	Stage 2: Learners used the online forums to share experiences; search for and share relevant information and literature; question each other; investigate policy and strategies; and debate differences in perspectives about the issues.	Method: Learners presented a variety of ways in which the problem could be approached. To do this they needed to search for relevant techniques and determine which might give the best result.
Integration	Stage 3: Learners were joined by practising teachers who acted as experts. The experts provided another informed layer of perspectives and information but more importantly they assisted the learners in integrating the multiple sources of information and seeking multiple solutions.	Working: Possible worked solutions were shared and the relative merits of each were discussed.
Resolution	Stage 4: Learners were asked to create an action plan for their future learning and to reflect on their learning and the learning process of the project.	Conclusion: Learners were required to make connections between the aim and solutions.

Table 2. Mapping the educational experiences against the 4 phases of cognitive presence.

Table 3

Cognitive Presence Phase	**Education**		**Mathematics**	
	Number of posts	%	Number of posts	%
Triggering	8	8	12	14
Exploration	55	56	34	39
Integration	14	14	31	35
Resolution	17	18	3	3
No category detected	4	4	8	9
Total Posts	98		88	

Table 3. Distribution of phases of Cognitive Presence by discipline