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COGNITIVE PRESENCE IN PEER FACILITATED ASYNCHRONOUS ONLINE DISCUSSION: THE PATTERNS AND HOW TO FACILITATE

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ABSTRACT

This study, in the context of peer facilitated asynchronous online discussion, explored the characteristics and patterns of students' cognitive presence, and examined the practices that aimed to enhance cognitive presence development. Participants were 53 students from a graduate-level online course that focused on the integration of educational technologies. Data were collected from discussion transcripts, student survey, student artifacts, and researcher's observations.

Results demonstrated four phases of students' cognitive presence: Triggering event, Exploration, Integration, and Resolution. Among the four phases, students' cognitive presence tended to aggregate at the middle phases: Integration and Exploration. Percentage of the Resolution was very low. The distribution of students' discussion behaviors further revealed: a) the hierarchical relationship between the four phases: Integration and Resolution involved a higher-level of cognitive engagement, and Triggering event and Exploration involved a lower-level of cognitive engagement; b) the phase of Resolution heavily relied on experiment, while the other three phases heavily relied on making use of personal experience; c) creating of cognitive presence occurred in both the private space of individual activities and the shared space of having dialogues. The conversation analysis of threads and episodes explored the temporal evolvement of cognitive presence. The results showed that, in an ongoing discussion, students' cognitive presence evolved in a non-linear way, rather than strictly phase by phase as suggested by the PI model.

Experiments were designed and conducted to determine the effects of two pedagogical interventions – 1) providing guidance on peer facilitation techniques; 2) asking students to label their posts. The results showed that the Intervention 1 and the combination of two interventions credibly improved students' cognitive presence. They were especially effective in improving

Integration, a higher level of cognitive presence. After having added Intervention 2, cognitive presence increased from the first-half to the second-half semester, although the improvement was not found to be statistically credible[1].

This study confirmed the close association between and among cognitive presence, social interaction, and peer facilitation. The results clearly showed that Intervention 1 – providing guidance on peer facilitation credibly improved students' social interaction and peer facilitation. However, Mixed findings were obtained for Intervention 2 – asking students to label their posts. It was found that Intervention 2 positively increased students' social interaction. However, it did not show any impact on students' peer facilitation behaviors. It is also worth noting that the effect of the combination of two interventions was much larger than any single one of them.

Conversation analysis was conducted to zoom in on the dynamic process of discussion. The cases revealed that when students were provided with the guidance on peer facilitation techniques, they tended to use a variety of facilitation techniques in a strategic way to help peers to achieve a sustained and deeper-level conversation. Compared to the control group, the students in the treatment group showed more peer facilitation behaviors, which led to more conversations and more higher-level cognitive presence.

This study has unpacked the complexity of students' cognitive presence in a peer-facilitated discussion environment, especially when students are coached in performing teaching presence. The results shed light on the pedagogical practices and strategies of creating an online

[1] Note: According to the approach of Bayesian analysis, the 'significance' of evidence is referred to the 'credibility' of evidence. For example, if the difference between two groups is statistically significant, the expression in Bayesian analysis is 'the difference is statistically credible'.

learning community that incubates rich cognitive presence. Finally, implications are discussed for the research and practices in online instruction and discussion analytics.

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CHAPTER 1

INTRODUCTION

Online education is becoming more and more prevelent and important in higher education (Allen & Seaman, 2013). Though the overall higher education enrollment declined (Marcus, 2015), the enrollment of online education has been continuing—a consistently growing trend for 13 years (Allen & Seaman, 2016; Friedman, 2016). By fall 2014, more than 5.8 million students had enrolled in online courses; and among these students, about 2.85 million took courses exclusively online (Allen & Seaman, 2016). Adding to this, the year 2012 saw a new form of online education that elite institutions started to offer: Massive Open Online Courses (MOOCs). An increased and renewed interest has emerged in the potential of online education.

Context of This Study

Asynchronous Online Discussion

Asynchronous online discussion (AOD) is a prominent activity in online courses (Chan, et al., 2009; Gao et al., 2013; Gulbrandsen, et al., 2015; Hung & Chou, 2015; Thomas, 2013; Wyss, Freedman, & Siebert, 2014). AOD has the potential to support active learning. It provides students a platform where they can communicate with others, rather than being isolated and overwhelmed with scripted videos and readings. In discussion, students are exposed to perspective diversity, conflicts, and dilemmas, which help generate extra learning activities such as explanation, disagreement, and negotiation (Dillenbourg 1999; Doll, 1993). At the same time, cognitive mechanisms, such as deep knowledge elicitation, knowledge sharing, or idea integrating, are likely to develop (Dillenbourg 1999). In these activities, learners take on the role

as knowledge constructors rather than priori knowledge spectators, receivers, or tellers (Meyer, 2002; Scardamalia & Bereiter, 1993).

In AOD, students explicitly express their thoughts through writing. By externalizing what is in their mind into text, they generate concrete ideas that they can work on in the interaction activities, such as explaining, clarifying, questioning, and connecting (Bereiter, 1994; Vonderwell, 2003; Wells, 1999). These archived texts in AOD also constitute a shared knowledge base that can be consulted in the future (Olson, 1994). Since they can conveniently refer to previous messages, students may become more reflective about or aware of their own ideas and others' positions (Wegmann & McCauley, 2014). Besides, the asynchronous nature of AOD allows students the time to search for more information (Lee, 2012), improve ideas (Chan, et al., 2009), and provide in-depth feedback to peers (Groeling, 1999). These pedagogical benefits of discussion contribute to improving students' learning outcome. Some studies have reported that students' participation in AOD highly correlates with their final grades and retentions in online courses (e.g. Cheng, et al., 2011; Coetzee, et al., 2014; Palmer, et al., 2008).

However, simply adding AOD to an online course cannot guarantee the quality of interaction and learning. Hew and Cheung (2010) reviewed 110 empirical studies on AOD in K-12 and higher education contexts and found that students' limited participation in AOD was a "persistent and wide spread problem" (p.572). Particularly, students contribute no or few posts (Hara, et al., 2000; Lee, et al., 2011), they simply answer instructor's questions without extending the discussion (Cheung & Hew, 2006), or the discussion terminates prematurely when they fail to receive prompt feedback (Hewitt, 2005; Jeong 2004). Even if students appear active in the forum, problems still emerge, such as the conversation flow lacks focus (Gao, et al., 2013), too much redundancy in content (Vonderwell, et al., 2007), dialogue stays at the social surface

level (Gunawardena, et al., 1997; Hew, et al., 2010), or students do not show any deep thinking and higher level knowledge construction (Cheung & Hew, 2006).

Education is fundamentally about the constructive interaction and convergent conceptual change (Koschmann, et al., 1994; Roschelle, 1992). Recognizing this, Harasim (2000) pointed out that discourse is the "heart and soul" of online education (p.51). Since AOD is an important platform that promotes such discourse, the quality of the dialogue that happened on this platform can largely explain the educational success and failure of an online course (Harasim, 2000; Mercer, 2007). Then the pressing question becomes: how can we shape a meaningful educational experience in AOD that boosts quality discussion?

Community of Inquiry Framework

Garrison et al. (2000) proposed the Community of Inquiry (CoI) framework that identified the factors neccesasry for creating high-quality online education. CoI is a well formulated theoretical framework. In the past two decades, it has been validated by a number of studies (e.g. Arbaugh & Hwang, 2006; Garrison, et al., 2004; Shea & Bidjerano, 2009), and translated into practices in various contexts (e.g. Archer, 2010; Lambert & Fisher, 2013; Pellas, 2016).

CoI emerged from the context of asynchronous text-based group discussion (Garrison & Anderson, 2010). From a social-constructivism perspective, it aims to create a community of learners whose critital discourse and reflection can be well facilitated (Garrison et al., 2001). Unlike the traditional online education perspective that assumes students work independely from each other, CoI emphasizes the inquiry as a whole community (Garrison & Anderson, 2010). Garrison and Anderson (2003) described this community as "an asynchronous ecology" where students take responsibility and control for their learning, and higher-order learning is expected

to be achieved through critical thinking, meaning negotiation, idea creation, and knowledge construction (p.4).

There are three key elements that contribute to developing such a community: social presence, teaching presence, and cognitive presence (Garrison, et al., 2000). Social presence is about the social interaction among participants. Teaching presence is the design, facilitation, and direct instruction performed by the instructor or any participants in the community. And cognitive presence points to the cognitive process and outcomes associated with learning. CoI assumes that learning occurs in the synergy of the three (Garrison, et al., 2000).

Cognitive Presence

Among the three elements, the majority of the previous work has focused on how to create social presence in students' discussion (e.g. Gunawardena & Zittle, 1997; Rourke, et al., 2007; Tu & McIsaac, 2002). However, the quantity of social interaction does not necessarily indicate the quality of discussion (Kim, et al., 2007). Some researchers voiced their concern toward the phenomenon they have observed: students showed high participation frequency, yet the discussions still stayed at a lower intellectual level (McLoughlin & Luca, 2000; Schellens, et al., 2005). Garrison and Cleveland-Innes (2005) acknowledged that social presence and interacting is not enough, more research is needed to understand students' learning and thinking from the cognitive lens. In a productive learning community, students "do not only interact," they "interthink" (Mercer, 2007, p.39). Thus, in recent years, the design and delivery of online courses has shifted to establishing cognitive presence and achieving higher-order learning outcomes (Akyol & Garrison, 2011).

Cognitive presence can serve as an important indicator of the quality of the educational experience in AOD. Garrison et al. (2001) defined cognitive presence as "the extent to which

learners are able to construct and confirm meaning through sustained reflection and discourse" (p. 11). The concept of cognitive presence has its roots in the theories of critical and reflective thinking (Garrison & Anderson, 2003). The ability to critically think is valued in all the knowledge-based work and is also a vital competency for citizens to participate in a democratic and rational society (Facione, 1990). Critical thinking is also the core capability addressed by this term.

In addition, Garrison and Anderson (2003) proposed the Practical Inquiry (PI) model that has operationalized this concept and described how critical thinking and inquiry develops. Research endeavors have been made to investigate students' cognitive presence in AOD (e.g., Garrison, et al., 2001; Meyer, 2003; Panwan et al., 2003, Vaughan, et al., 2005). A common pattern was revealed—students' cognitive presence tends to aggregate at the lower level (e.g., Garrison, et al., 2001; Meyer, 2003; Panwan et al...2003, Vaughan, et al., 2005). This observation is also consistent with the AOD issues discussed in the above paragraphs.

Therefore, to enhance the quality of online courses and create a meaningful experience for students, it is important to understand the characteristics and patterns of students' cognitive presence in AOD environments and the practices that can support their cognitive presence development.

Strategies to Improve Cognitive Presence

According to Garrison (2003), effective facilitation and the opportunities for metacognition are important strategies to achieve the goal of promoting cognitive presence.

Metacognitive awareness. For increasing the metacognitive awareness, Garrison (2003) suggested sharing the PI model with students and encouraging them to stay aware of their cognitive presence development. Such awareness of "where they are" in learning/thinking can

assists students in selecting and using meta strategies in learning activities (Garrison & Anderson, 2003). In addition, higher order thinking in online discussion requires the proper use of these meta-level strategies (Tobias & Everson, 2009).

Recent studies have started to pay attention to the metacognition issue in developing a community of inquiry and students' cognitive presence in AOD (Akyol & Garrison, 2011; Garrison & Akyol, 2015). A limited number of studies have applied the strategy of sharing the PI model and asked students to label their posts regarding their cognitive presence (de Leng, et al., 2009; Pawan et al., 2003). However, our understanding on whether/how such metacognition practice facilitates students' cognitive presence has still been less than satisfactory (Akyol & Garrison, 2011).

In this study, the metacognitive practice refers to the practices recommended by Garrison (2003): share the PI model with students and keep them aware of their cognitive presence. Particularly, a guidance manual was provided to students which explained the concept of cognitive presence, what a PI model is, and the steps of labeling their cognitive presence in the post.

Facilitation. Facilitation of discourse is another line of research on studying how to promote students' engagement and increase the quality of online education. Numerous studies have investigated facilitation practice that can alleviate the problems that have emerged in AOD (e.g. Gerber, et al., 2005; Mazzolini, et al., 2003; Rovai, 2007). In these studies, considerable attention has been devoted to the facilitation provided by instructors or tutors (Hew & Cheung, 2011). However, some recent studies voiced concerns about instructor facilitation and started to question whether instructor is the right candidate to facilitate a discussion (Hew, 2015).

One of the concerns is the "authoritarian presence" of the instructor might turn the discussion into an instructor-dominant lecture (Rourke & Anderson, 2002b, p. 4). Some students might feel nervous in expressing their thoughts and feelings when the instructor is present (Hew et al. 2010). Fauske and Wade (2003) found in their study that the instructor's messages might be treated as the authoritarian answer by students, and this will further oppress their thinking, ideas, and voices. Dennen (2005) observed the following phenomenon—that when the instructor frequently presented in the discussion, students were more likely to interact with the instructor rather than with peers. Besides, Mazzolini and Maddison (2003) pointed out that some facilitation techniques used by the instructor may not generate the effects as expected. For example, students tend to consider the questioning from the instructor as a form of assessment and thus become hesitant to share their thoughts. Another concern is the high demand of time and energy input for facilitating an online discussion effectively (Hew, 2015). Due to the asynchronous nature, being a facilitator is like being a parent who is "on duty all the time" (Hew, 2015; Hiltz, 1988, p.441). It is not practical for an instructor to properly facilitate an active discussion when the class size is large. Thus, it is not surprising that currently in most MOOCs that have thousands of students, the forum discussions only have minimal or no facilitation (Mak, et al., 2010).

Peer Facilitation. Poole (2000) suggested the use of a peer facilitator to decentralize the role of instructor and share the role with students in building productive online learning communities. His study provided the evidence that, with the duties of facilitator, students became more involved and responsible for the discussion. Hew (2015) considered peer facilitation as an empowering opportunity for students' learning. He pointed out that when peers facilitate the discussion, students feel more comfortable expressing their thoughts, can share the learning

responsibility and build a stronger sense of community, while at the same time can get the hands-on experience of being an online facilitator. Topping (1996) agreed that the peer-facilitated environment encourages self-efficacy, motivation, and shared empathy, all of which leads to the self-regulation of group learning. In this environment, students can serve as knowledge agents to contribute their expertise since they have diverse backgrounds and skill sets (Scardamalia, 2002). Their distributed expertise creates the proximal zone of development for each other and provides scaffolding for the development of understanding (Kennedy & Kennedy, 2010). Therefore, the teacher function can be achieved, to some extent, by this type of interaction among students (Baran, 2009).

Kennedy (2004) supported peer facilitation in a community of learning from a system view. He used the term autofacilitation to describe the mechanism of peer facilitation that boosts the development of a community system. In autofacilitation, "each individual member of the group excises to some degree the leadership skills that enable the maturation process as a whole" (p.753). The idea of autofacilitation may shed light on the solution for the challenges in facilitating MOOCs. Stewart (2013) recognized this and proposed the potential of peer facilitation in facilitating the discussion activities in MOOCs.

Despite the potential of peer facilitation, previous research on facilitation in AOD has primarily focused on the facilitative role of instructors (e.g., Dennen & Wieland, 2007; Gerber, et al., 2005; Mazzolini & Maddison, 2007; Masters & Oberprieler 2004). According to Chan et al. (2009), the mechanism of peer facilitation is, in essence, different from that of instructor facilitation, as the former grows out of a lateral relationship, but the latter is based on a higherarchical relationship. Thus, different effects/outcomes might be generated even though the same facilitation technqiues are used. However, relatively little is understood about how peer

facilitation shapes the development of AOD. This gap has been recognized by some scholars who argued that peer facilitation deserves more research attention (e.g., Baran & Correia 2009; Chan, et al., 2009; Gašević, et al., 2015; Hew, 2015; Ng, et al., 2012).

In peer-facilitated AOD, pedagogical knowledge on peer facilitation can help online instructors provide quality support to student facilitators, especially those novice learners who have limitted domain knowledge and facilitation skills (Choi, et al., 2005). Onah, et al. (2014) observed that most student facilitators lacked a pedagogical understanding of facilitating a forum discussion. They claimed that this was a main cause for the lower completion rate in the class that employed the student-facilitated mode. Students might not spontaneously function effectively to facilitate a conversation without appropriate guidance (Fischer, et al., 2013; Scheuer, et al., 2014; Weinberger, et al., 2005). Particularly, they may dominate the discussion but fail to listen to peers' voices, ignore the important aspects of the discussion, or miss the opportunities that can move the discussion to a higher level. All of this will consequently influence the quality of discussion if these student facilitators are not well supported or trained.

There is clearly a need for external supports for student facilitators on the techniques to facilitate a discussion (Choi, et al., 2005). Several studies have reported that the scaffolds of facilitation techniques (e.g., questioning, summarizing, clarifying) can effectively guide students' facilitative behaviors and then create a productive and meaningful discussion (e.g., Brown, 1989; King et al., 1998; Scardamalia et al., 1989). According to Choi et al. (2005), the proper use of the facilitation techniques can even compensate for a lack of prior knowledge and help novice students to function as an "intelligent novice" in facilitating a discussion. However, the exsiting research on peer facilitation is still limited as they did not clearly describe or explain the peer

facilitation techniques, nor how these techniques can influence students' discussion and learning (Hew & Cheung, 2011; Ng, et al., 2012).

Hew and Cheung (2011) pointed out another limitation of current research is the aspect they look at in investigating the effects of peer facilitation. To date, researchers primarily focus on the length of discussion threads (Chan, et al., 2009; Hew & Cheung, 2008). Few research studies have been done to examine how peer facilitation influences students' intellectual enagement in the discussion.

Gaps in Current Literature

In summary, three gaps can be identified in the existing studies.

Firstly, research on the characteristics of cognitive presence has primarily been conducted in the context of instructor-centered AOD; little is known in the context of peer facilitated AOD. Besides, previous research has studied students' cognitive presence from a static view and at a macro level by calculating and comparing the percentages of different types of cognitive presence. However, in AOD, students create their cognitive presence in an emergent and complex way (Kennedy, 2004). And the discussion is an ongoing nonlinear process of generating new topics and unexpected incidents (Kennedy & Kennedy, 2010). Thus, if zoomed in on the dynamic process at a micro level, there remain many unanswered questions about how students develop their cognitive presence, how the pattern changes overtime when peers facilitate the discussion, and how students' cognitive presence distribution is related with students' specific discussion behaviors. Secondly, few studies have sought to examine the facilitative role of students in developing AOD and building cognitive presence. Less attention has been paid to the effective peer facilitation techniques, how student facilitators use the techniques, and how the facilitative behaviors influence students' cognitive presence development. Lastly, metacognitive

practice is an important area of enquiry; however, relatively little is known about whether and how these practices affect students' cognitive presence, and how the effects of these practices interact with the effects of peer facilitation.

Research Questions

This study attempts to work on bridging these identified gaps, and particularly aims to answer the following research questions:

1. What are the characteristics and patterns of students' cognitive presence in peer-facilitated AOD?
2. How does peer facilitation and the guidance of peer facilitation techniques affect students' cognitive presence? What are the effective peer facilitation techniques that promote cognitive presence?
3. Whether or not the metacognitive practice affects students' cognitive presence in peer-facilitated AOD?

CHAPTER 2

LITERATURE REVIEW

Chapter Overview

In this chapter, I reviewed the existing literature on cognitive presence and the facilitating practices. This review outlined the theoretical perspective that defines what is learning and the theoretical framework that framed the understanding on cognitive presence and quality education experience. The concept of cognitive presence was further explored. The review also presented the fundamental ideas and key factors relevant to cognitive presence and effective facilitating. The goal of this review is to develop a clearer understanding of cognitive presence and the facilitative condition in the context of a community of practical inquiry.

Theoretical Foundations

Constructivism View of Learning

Constructivism and objectivism are the two philosophical paradigms on understanding the nature of reality, knowledge and human learning (Jonassen, 1991). Objectivism assumes that reality is absolute and external, and knowing and learning is to mirror and represent reality (Lakoff, 1987). Oppositely, constructivism argues that "reality is made, not found" (Bruner, 1996, p.19), and knowledge is constructed in people's mind (Goodman, 1987; Jonassen, 1991). Compared to objectivism-oriented learning that focuses on memorizing and comprehending the pre-existed knowledge, constructivism emphasizes creating meaning (Glaserfield, 1989). From the constructivism view, learning occurs in the interpreting of information rather than the recording of it (Resnick, 1989). Thus, the product of constructive learning is people's interpretation (Jonassen, 1995), and the goal of education is to help learners become better "architects" and "builders" of knowledge (Bruner, 1996, p.20).

In constructivism, there are two primary focuses. One is the cognitive constructivism that considers knowledge construction as individual cognition, and the other is social constructivism that regards learning as a Sociopolitical process (Fosnot, et al., 1996).

Jean Piaget, the psychologist in the camp of individualistic cognitive constructivism, posited that knowledge is the product of the functioning of individuals' cognitive activities (Fosnot, 1996). No mental structure is inborn but is instead created in the process of cognitive construction. He borrowed biology terms, such as "assimilation", "accommodation", "adaption", and "equilibration" to describe the learning process— individuals constantly *assimilate* and *accommodate* in the process of *adaption*, and eventually arrive at a state of *equilibration*. *Cognitive equilibrium* is a key concept in Piaget's theory. Cognitive equilibrium defines a state of cognition in which students yield expected results without any conceptual conflicts after having developed new knowledge and complex mental structure (Glaserfield, 1989). Piaget explained the equilibration mechanism as below:

> … one obtains an equilibrium aimed at both preserving the scheme and taking into account the properties of the (new) object. If, however, these properties turn out to be unexpected and interesting, the formation of a subscheme or even of a new scheme has to prove feasible. Such new schemes will necessitate an equilibration of their own (Piaget, 1980, p.31).

Lev Semyonovich Vygotsky emphasized the social origins of cognition and argued that learners are not isolated individuals and social interaction is an integral part of knowing and learning. He proposed that knowledge is the product of social constructive efforts by a group/community of individuals (Dillenbourg, 1995; Nelson, 1993). In the process of constructing knowledge, "the true direction of development of thinking is not from individual to the societal, but from the societal to the individual" (Vygotsky, 1986, p.36).

Vygotsky proposed the concept of *zone of proximal development* (ZPD) that bases learning on social actions. In his words, ZDP was defined as:

> …the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978, p.86).

A basic idea behind this concept is that learning is inherently social: students can develop their learning with the assistance of more capable others. Vygotsky critiqued the learning assessment that only looked at individual problem solving, and argued that the knowledge progress achieved by cooperation with others can reveal more about the capabilities of learners (Fosnot, et al., 1996).

Scaffold is another concept proposed by Vygotsky (1986) to understand the support from others in the interaction. Scaffold is a metaphor from the field of architecture construction that refers to a temporarily supportive framework during erection or modification of a building. Powell et al. (2009) explained scaffold through this example: "when a child learns to count objects alone he or she may miss a number; however, if a teacher holds their fingers and points directly to the object with them, counting out louder together, the child can then do the counting correctly by themselves" (p.244). Stone (1993) expanded the concept of scaffold from focusing on hierarchical adult-child interaction to lateral peer interaction. In group learning, anyone who has different perspectives, knowledge, or skill sets can provide a scaffold to others' learning. The scaffolds can take the forms of feedback, encouragement, explicit guidance, and modeling (Salomon & Perkins, 1998; Scardamalia, et al., 1989).

The constructivism perspective guided this dissertation study in defining learning and understanding the process of knowledge construction in students' online discourse. Although the study relied primarily on the perspective of social constructivism that emphasizes the social-cognitive interactions among students, both social and individual cognitive constructivism are used to map out the different aspects of the learning process. The major concepts from social

constructivism, such as *zone of proximal development* and *scaffold*, helped understand the mechanisms of students' collective cognitive development. The concepts from cognitive constructivism, such as *conceptual conflict*, *assimilation*, *accommodation*, and *cognitive equilibrium,* helped explain students' cognitive development at the individual level.

Community of Inquiry

The concept of community of inquiry. Community of inquiry is a notion that is social-constructivism oriented. The literature on community of inquiry has its roots in Peirce's philosophical work on scientists' inquiry as a community (1955). According to Peirce, a community is a group of scientists who've come together to inquire, collaborate, negotiate, and eventually arrive at the same conclusion to explain reality. He considered a community of inquiry as a model for knowledge production in which individuals, as a community, can create rational understanding toward reality (Pardales, et al., 2006).

Later, Lipman and his colleagues (1980) further developed the notion 'community of inquiry' in education. They employed community of inquiry as a teaching method to teach philosophy through discussion in elementary classrooms. This method aims to convert a classroom into a community in which students take the active role and they "listen to one another with respect, build on one another's ideas, challenge one another to supply reasons for otherwise unsupported opinions, assist each other in drawing inferences from what has been said, and seek to identify one another's assumptions" (Lipman, 1991, p. 15). Here, community of inquiry became a form of pedagogy—students can think with others (Kennedy, 2004). Wells (1999) applied the approach of community of inquiry to knowledge-building activities in a broader educational context. To Wells, to create such a community, students are encouraged to work in groups on the topics of mutual interest, and "a critically important activity is whole class

meetings for review and reflection on what is planned, in progress or has been achieved" (p.7). In this process, students can get chances to compare different perspectives and build knowledge in a critical way.

Based on Lipman's work, Garrison and Anderson (2003) extended the approach of community of inquiry to the context of online education. They expected a community-like environment could support students' higher-order learning that "inevitably involves a considerable amount of discourse" (Bereiter, 1992, p.352). They described the community of inquiry as a group of students and teachers who work together to develop, construct, facilitate, and validate understanding that leads to further learning.

Community of Inquiry framework. Community of inquiry is also a pedagogical approach to support the discourse associated with a higher level of learning in online education (Garrison, 2007). According to Wells (1999), how to build a community of inquiry is an important question to consider in employing this pedagogy. Garrison, Anderson, and Archer (2000) then developed the Community of Inquiry (CoI) framework to summarize the crucial elements in creating a quality online educational experience that is characterized by communities of inquiry.

This framework outlined the social, teaching, and cognitive dimensions to capture the core dynamics of a community of inquiry. The inclusion of the social and cognitive aspects was based on the socio-constructivism nature of the concept of CoI (Swan & Ice, 2010). Garrison (2007) also acknowledged that this was inspired by Henri's work (1992) on the social and cognitive processes in online collaborative learning. While at the same time, Garrison and his colleagues examined the activity transcripts (e.g., forum discussion, project reports) in various online courses (Shea & Bidjerano, 2008). They added the teaching aspect to include the

instructional support from the teacher. Therefore, three dimensions were finally identified: social presence, cognitive presence, and teaching presence. Social presence examines the social dynamics in the community. In CoI, social presence was defined as the ability of learners "to project themselves socially and emotionally" (Garrison & Arbaugh, 2007). Cognitive presence examines students' cognitive involvement and development in "exploration, construction, resolution and confirmation of understanding" (Garrison, 2007, p.65). Teaching presence explores the design, facilitation, and direction of cognitive and social processes in the community (Garrison, et al., 2001).

In addition to having identified the core elements of a community of inquiry, Garrison (2010) pointed out that a CoI is also a "process model" that outlines the dynamic relationships among cognitive, social, and teaching aspects of an educational experience. Fig.1 illustrates the interactions among the three elements. CoI assumes that a higher level of learning is more likely to occur when all three forms of presence are present and interact (Garrison, et al., 2003 b). According to Garrison and Akyol (2013), social presence can create a dialogical environment in which students get the chance to connect to what others are thinking, and teaching presence helps students regulate their cognition throughout the learning process. Therefore, social presence and teaching presence can provide the conditions for cognitive presence to flourish (Layne & Ice, 2014). Shea and Bidjeranoto's (2009a) study, in which more than 2000 online learners participated, provided evidence for this relationship. They found that 70% of the variation in students' cognitive presence can be explained by the teaching presence and social presence. Garrison, Cleveland-Innes, & Fung (2010), Archibald (2011), and Kozan et al. (2014) further confirmed Shea and Bidjeranoto's finding. Their studies presented the evidence that all three presences are interconnected. Kozan et al. (2014) found the strong positive correlation between

any two types of presence. Garrison et al.'s (2010) detailed examination of the causal relationships among the three showed that teaching presence directly influence the social and cognitive presence, and social presence mediated the effects of teaching presence on cognitive presence. In contrast to Garrison, Kozan et al. (2014) emphasized the dominant role of cognitive presence, claiming that cognitive presence can exert a significant influence on the relationship with teaching and social presence.

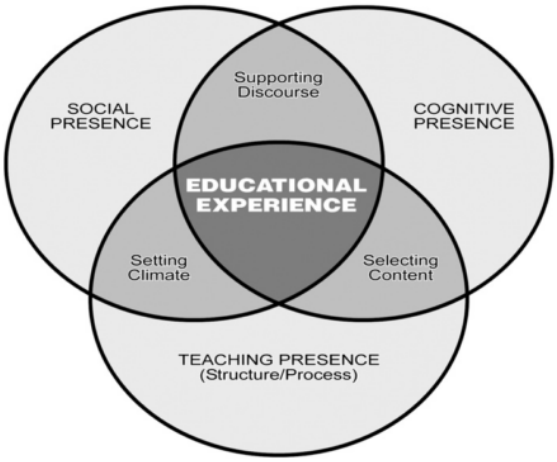


Figure 1. Community of practical inquiry framework

CoI is also a framework that measures the core elements of developing an online learning community. After having defined and described these elements, the research team continued to develop instruments, such as surveys or coding schemes, to measure the components in the framework (Arbaugh, et al., 2008). A number of studies were conducted to examine one or more components (e.g., Akyol & Garrison, 2008; Shea & Bidjerano, 2008; Swan, et al., 2008). Some researchers conducted studies to validate the survey that reflects the CoI framework in different subject and cultural contexts. For example, Shea and Bidjeranoto (2008) found that the three components can explain the variation of the levels of students' learning and their perceptions of the online learning experience. The data in Swan et al.'s (2008) study supported the construct validity of CoI. Arbaugh, et al. (2008a), Arbaugh, et al. (2008b), Shea & Bidjeranoto (2009),

Kozan & Richardson (2014), and Yu & Richardson (2015) verified a clear factor structure of CoI and provided empirical support for the ability of this framework in predicting the perceived learning and experience satisfaction in online courses.

Application of CoI framework in online education research and practices. CoI framework has been widely applied in the research and practices in education in helping educators to make sense of the issues in establishing a robust community of inquiry.

First of all, CoI was used as a guide in the design and evaluation of online instruction. Szeto (2015) operationalized the CoI as an instructional approach and the three presences as the instructional components in courses of blended synchronous mode. He adapted each presence and the intersection between any two to teaching or learning activities. For example, for the component of cognitive presence, he described the instructional method as "attainment of the intended learning outcomes through quizzes, presentation of individual exercises, peer evaluation of group projects and peer feedback on discussions aimed at deeper levels of learning" (p.194); for the component of teaching/cognitive presence intersection, he summarized as "present content knowledge; explain theories; demonstrate skills; and link content knowledge with learning activities" (p.194). He also used the coding schemes provided by CoI to evaluate the instructional effects of these components. Similarly, guided by CoI, Lambert et al. (2013) designed and developed an online course; Mills et al. (2016) redesigned a research course of blended form in the context of nursing education; Posey et al. (2014) designed team learning activities for nurse practitioners in both synchronous and asynchronous online environments; and Randrianasolo (2013) converted a college English Composition class into the online version. Vaughan (2010) adapted CoI to a faculty professional development program that guided faculty

members to redesign blended courses. In this program, faculty members went through an inquiry process in which they reflected on a series of questions that were derived from CoI.

Some researchers extended the use of CoI to other learning environments. Kim et al. (2014), based on CoI, developed a design framework and principles for creating flipped classrooms in universities. Kiili (2005) utilized CoI in educational games to design and facilitate learners' gaming experience. Pellas and Boumpa (2016), guided by the indicators of the three presences in CoI, developed an instructional design framework and the associated learning activities for a 3D multi-user virtual environment. Lowenthal and Dunlap (2010) explored the way of using digital storytelling to create social presence in achieving a productive community of inquiry. Hamza-Lup and Stanescu (2010) examined students' multimodal interactions using haptic technology through the lens of CoI. Unlike the work focused on the technology-based learning environment, Warner (2016) applied CoI in traditional face-to-face classrooms to design and organize students' assignments, class activities, and teaching strategies. He found the results of using the CoI approach in traditional classrooms were also "encouraging".

In some recent studies, CoI were used as a framework to evaluate the quality of the educational experience or the effectiveness of instructional interventions or programs. Burgess et al. (2010) and Pellas & Kazanidis (2014) employed the CoI in the multi-user virtual environment (*Second Life*) to assess students' interactions in terms of the three presences, and examined whether/how student variables, such as computer self-efficacy, situational interest, and academic self-concept, can predict the three presences. Rubin et al. (2013) used CoI to evaluate the effectiveness of the affordances of the learning management system. Archibald (2010) adopted CoI to evaluate the effects of a learning resource project he developed to help health students and professionals to learn about research design through video-based materials and community

discussions. Archer (2010) went beyond the protocol analysis of discussion transcripts, and he applied CoI to an entire course to assess other class activities such as journals or term papers.

Additionally, Garrison et al. (2010) expected this framework to provide order, parsimony, and even methodology to studying online learning. The three presences served as the conceptual elements with each representing an important facet of the learning experience (Szeto, 2015). In a considerable amount of studies, the CoI framework helped decompose the complexity of online learning experience. In the case study of the activities of instructors and adult learners in an online course, Ke (2010) used the three presences and the corresponding indicators in CoI as the story structure to describe the case. Rather than examining all the elements at the same time, some research primarily studied how a single type of presence functions independently. For example, Gunawardena & Zittle (1997), Rourke, et al. (1999), Rourke & Anderson (2002a), Tu & McIsaac (2002), and So & Brush (2008) investigated how students create their social presence in virtual environments, and how social presence is related with students' perceived learning and course satisfaction. Akyol & Garrison (2011), Shea & Bidjerano (2009b), and Stein, et al. (2007) investigated students' cognitive presence demonstrated in online discussion to reveal how they develop their critical thinking and shared understanding. Morgan (2011), Shea, et al. (2003), and Swann (2010) examined the teaching presence to explore the effective interventions that can enhance the other two presences.

Another line of research has focused on revealing a bigger picture by studying the relationship between the three presences and other variables of interest in understanding the dynamics within an educational experience. For example, Gibson et al. (2012) and Kim et al. (2011) studied the relationship between demographic factors (e.g., gender, ethnicity, and age) and the level of the three presences. Kim et al. (2011) also examined the influence of media use

and instructor teaching quality on CoI. Boston et al. (2014) and Joo et al. (2011) examined the relationship between three presences in CoI and students' persistence and satisfaction in online programs. Kucuk et al. (2013) studied the relationship between the three presences and preservice teachers' course satisfaction, academic success, and learning motivation in both face-to-face and blended classrooms. Traver et al. (2014) explored the relationship between the three presences and the online course completion of community college students. There were a few emerging studies that introduced a new dimension (e.g., time, subject, course orientation) in examining the pattern of the three presences in CoI. For example, Arbaugh et al. (2010) investigated the disciplinary effects by examining students' perceptions on cognitive presence, teaching presence, and social presence in pure and applied, soft and hard disciplines. Akyol and Garrison (2008) explored the temporal dynamics of students' online learning experience by looking at how the three presences change overtime. Akyol et al. (2010) investigated the patterns of the three presences in courses that were characterized by different theoretical orientations such as objectivist/constructivist or individual/collaborative.

Besides looking at CoI through the lens of a new dimension, some researchers sought to improve CoI by adding new components. Shea et al. (2012, 2014) emphasized the importance of students' self-regulation, and proposed to include a new component: *learning presence* to the framework. Cleveland-Innes et al. (2014) turned their attention to the emotional aspect in online learning. They suggested the addition of *emotion presence* to studying the community of inquiry and proposed a revised framework: *Relationship of Inquiry*.

Cognitive Presence

The CoI framework emphasizes deep learning and higher-order thinking, rather than any specific domain-dependent learning outcomes (Garrison, et al., 2001). Garrison (2003) pointed

out that, in achieving this goal, "understanding of cognitive presence is a priority" (p.50). This section discusses the meaning of cognitive presence to help make sense of this concept, and reviewed the current research on this topic to help explain where this dissertation study is in the field.

Presence

The concept presence has its origin in media studies (Bazin, 1967; Cummings & Bailenson, 2016; Sheridan, 1992). The film theorist André Bazin used this term when he explained what is cinema (Bazin, 1967). Later, when various technologies became widely available, the discussion of this concept increased with regard to the challenge that confronted media researchers: how to create the virtual user experience that is natural and real when users enter mediated environments (Heeter, 1992). It soon became a central question for these media scholars to figure out how "a sense of being there" could be created (Lee, 2004). In media literature, the "sense of being there" was also referred to as "telepresence" (e.g., Held & Durlach, 1992) or more commonly as "presence" (e.g., Rheingold, 1991), which was used to describe "the subjective experience of being in one place when one is physically in another" (Witmer & Singer, 1994). Steuer (1992) explicated this concept, and defined presence as "the extent to which one feels present in the mediated environment" (p.76).

To make sense of what presence is, researchers have made several attempts to define this concept in different ways (Cummings & Bailenson, 2016). Lombard et al. (1997), through an extensive literature review, summarized six types of presence: 1) the ability of media of being socially warm and intimacy; 2) real world representation; 3) the feeling of transportation that you are transported (by media) to a single place in the virtual world, or the virtual world comes to you, or you and others are transported to a shared space in the virtual world; 4) presence as

perceptual and psychological immersion in the virtual world; 5) the ability to interact with other agents/avatars in the mediated environment; and 6) the ability to interact with the mediated environment. By focusing on #4 and #5, the term presence has been used in the field of online education to address "the degree of presence students perceive in online interaction with an instructor and/or with other students" (Russo & Campbell, 2004). Social presence and teaching presence in CoI belongs to this category.

Interacting elicits inter-thinking. It is wildly agreed upon that a high level of this type of presence of instructors and other students can lead to higher level of psychological presence which involves the active function of people's cognitive processing systems (Cummings & Bailenson, 2016; Lombard et al., 2000; Russo & Campbell, 2004). Witmer et al. (1994) reported the empirical evidence for the close association between the presence and cognition in virtual environments. Slater and Wilbur (1997) suggested that the presence in a media environment is inherently a representation of how a user/learner is consciously and intellectually engaged in being present. Sheridan (1992) even argued that all types of presence are fundamentally a mental manifestation. To address learners' cognitive immersion in the mediated learning environment, Garrison et al. (2001) then proposed the concept of cognitive presence to describe the presence of a learners' cognitive state.

What is Cognitive Presence

According to Garrison et al. (2001), cognitive presence refers to "the extent to which learners are able to construct and confirm *meaning* through sustained *reflection* and *discourse*" (p. 11). To understand the meaning of this concept, I decomposed the definition into some aspects, with each characterized by a key word.

The definition of cognitive presence was grounded on Dewey's work on reflective thinking (Garrison & Anderson, 2001). In this definition, meaning is the product of being cognitively present. According to Dewey (1928), meaning is "the appreciation of things worthwhile, and the values to which these things are relative" (Dewey, 1928, p.49). The value here is constructed through identifying the relationships "among the elements of an experience, between that experience and other experiences, between that experience and the knowledge that one carries, and between that knowledge and the knowledge produced by thinkers other than oneself" (Rodgers, 2002, p.848). These identified relationships then constitute the interpretation individuals can use to make sense of their experience (Jonassen, 1991).

The mental operation involved in recognition of the relationships characterizes the key function of reflection (Dewey, 1944). Dewey (1933) considered reflection an inquiry process in which individuals constantly generate and test their ideas and thoughts. He proposed five steps of a complete act of reflection: 1) Directly leap to possible solutions when confronted with a disturbed situation. The ideas generated are spontaneous and automatic responses to situation. 2) Identify and define the problems in a rational and intellectual way. Better ideas of the solution may be created. 4) Refine and modify solution through reasoning. A hypothesis that directs the following actions might be produced. 5) Experiment to test the hypothesis. Adopting of ideas then verifies the correctness of the hypothesis. Dewey acknowledged that, in reflection, the sequence of the five steps is not fixed. Through continual trial and testing, reflection is an iterated "active, persistent, and careful" cycle of these steps (Dewey, 1938, p.9). The iterative nature is also reflected in the definition that students create cognitive presence in a sustained way.

Reflection needs an environment that encourages interaction with others (Rodgers, 2002). Dewey even claimed that "a man really living alone (alone mentally as well as physically) would have little or no occasion to reflect…" (Dewey, 1916, p.4). To him, meaning created in reflection not only resided in relationships of "bare facts", but more importantly in the consequences of human interactions (Dewey, 1925). The ideas from an individual's thinking can be developed and improved by exposing them to the community (Rogers, 2002). The interactions are very likely to involve language use, which helps frame and refine the reflective thinking (Clark & Schaefer, 1989). Adding to this is the social constructivism orientation of this concept; it is unsurprising that the definition of cognitive presence emphasizes the discourse aspect. In a community of inquiry, discourse is the written or spoken text in use that allows the communication among community members (Grimshaw, 2003).

Practical Inquiry Model

What is Practical Inquiry model. Built upon Dewey's (1933) model on the process of reflection, Garrison et al. (2001) developed a Practical Inquiry (PI) model to describe the process of developing cognitive presence. As illustrated in Fig. 2, the PI model includes four phases: Triggering Event, Exploration, Integration, and Resolution.

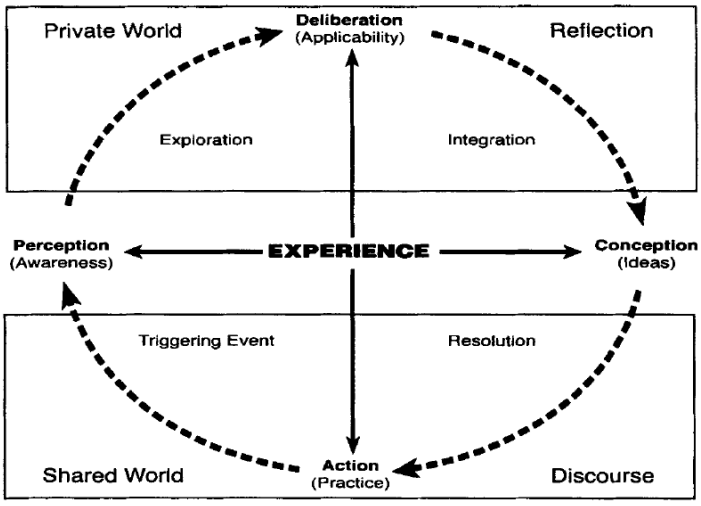


Figure 2. Practical Inquiry model (Garrison et al., 2001)

The first phase is Triggering Event. This is the initiating state of the inquiry. Students might be confronted with an innovative or disturbed situation that may elicit cognitive conflicts, curiosity, or the feeling of confusion. In dealing with the disturbance within the situation, students may explicitly express their feeling of puzzlement or struggle, or make attempts to locate and describe the problem. But their understanding toward the problem is still "vague and tentative". Triggering Events are, but are not limited to, emerging incidents. Garrison and Anderson (2003) suggested that a Triggering Event can also be a well-designed task from the instructor that can "ensure full engagement and buy-in from the students" (p.59).

The second phase is Exploration. Students explore different resources and ideas to develop a clearer understanding of the problem, and to generate or collect possible solutions and explanations. The common activities include brainstorming, information searching, and idea exchange. At this phase, the ideas generated tend to be like the spontaneous and automatic response to a situation without deliberation and justification. The information is simply collected, shared, and stored in a fragmented way, and students do not identify the relationships hidden in/between the information. Thus, this phase does not involve active meaning making but does prepare for its happening.

The third phase is Integration. Garrison and Anderson (2003) considered Integration as a "highly reflective phase" (p.60). Students start to make sense of the ideas and information they have obtained by identifying relationships from the resources at hand. They find out these relationships through activities such as comparing, contrasting, connecting, synthesizing, logical reasoning, elaborating, or explaining. They may also interpret and integrate the fragmented facts and ideas based on their past experience, prior knowledge, culture background, or any relevant tools. Possible outputs of this phase can be a justified explanation that reflects a solid

understanding on an issue, or a tentative solution or hypothesis that can guide the subsequent actions.

The fourth phase is Resolution. This is a phase for testing and verifying the correctness or effectiveness of a solution/hypothesis. Students may apply the solution or test their hypothesis in the real world. They might also generate new problems, which move them into a new cycle of critical inquiry. The testing can be done through observation or experiment. Garrison and Anderson (2003) acknowledged the fact that direct application of a proposed solution is not practical in some educational settings, and the testing of vicarious form should also be encouraged. For example, a possible vicarious testing can be mental modeling or thought experiment of a solution or hypothesis in which students describe in detail the application process and justify the results through a chain of reasoning.

As shown in Fig. 2, the four phases are all located at the interface between private world and shared world. The PI model assumes cognitive presence develops in both spaces. Students can arrive at any phase of cognitive presence through individual or collective activities. For example, students may explore through individually searching information, or through collaboratively brainstorming ideas. In the process of developing cognitive presence, they continually shift between the private world of individual reflection and the shared world of discourse (Garrison et al., 2003).

There are two continuums in Fig. 2: one is the deliberation-action, and the other is perception-conception. The former reflects students' activities from the abstract level to concrete level, and the latter represents the cognitive operations from surface perceptual awareness to deep idea processing. The PI model assumes that students iteratively transit between the two ends of the two continuums. Particularly, in Triggering Events, the disturbed situation comes

from an individuals' action or practice they are experiencing, and then come into their attention/perception/awareness. In this process, they recognize the problem they need to solve and may show the behaviors that represent the first phase of cognitive presence. In Exploration, with relevant resources having been collected and possible solutions having been produced, students move from simple awareness toward, to relatively more conscious consideration and understanding of the problem. In Integration, students construct meaning and form justified ideas through a series of integration activities. In this process, they transit from consideration of the problem (deliberation) to deeper conception. When they step into the phase of Resolution, students put the promising solution ideas into concrete action in the real world. In the PI model, the cycle of inquiry does not end here. More disturbed situations (dilemma, challenge, conflicts) are likely to emerge from the actions of applying ideas, which may elicit new Triggering Events.

Garrison, Anderson, and Archer (2001) considered the PI model as a process model that outlined the mechanism of creating and maintaining cognitive presence. The PI model portrayed cognitive presence as a progressive and dynamic cognitive process, rather than a static state. Ideally students go through the four phases to finish a full cycle of inquiry. Garrison et al. (2003) also pointed out that the four phases are not "immutable". In reality, students create and develop their cognitive presence in a complex and emergent way (Kennedy, 2004). This is a nonlinear and even chaotic process of encountering branching, recursion, ambiguity, conflict, and emergence of any incidents (Kennedy, 2004; Kennedy & Kennedy, 2010). Therefore, it is possible that some phases are "telescoped" or "reversed" in some occasions (Garrison & Anderson, 2003). The sequence of phases is not fixed and there's no rigid time unique to one specific phase (Chen, et al. 2014). Any phases may occur in any sequence and can recur iteratively until a satisfactory outcome has been achieved. This is supported by Doll (1993) who

wrote: “(the growth process of thought) will not proceed in a linear, sequential, accumulative, and stable manner; rather, it will occur sporadically and spontaneously as each individual builds a rich matrix of representation, utilizing multiple perspectives, consciousness presuppositions, and personal subjectifications” (p.124).

The PI model is inclusive to various forms of thinking as the inquiry process requires the integration of multiple cognitive processes (Garrison & Archer, 2000). This model is compatible with creative thinking, problem solving, intuition, or insight in the sense that different phases of cognitive presence may involve various distributions of these forms of thinking. For example, creative thinking can be stimulated through Exploration activities such as brainstorming that encourages the thinking of divergent nature; Core events in problem solving such as determining or testing a solution are also activities that characterize Integration or Resolution; intuition and insight, according to Garrison et al. (2003), are important subconscious aspects of rational thought in reflective thinking and they are likely to precede or accompany all phases of cognitive presence.

PI Instruments for measuring cognitive presence. To operationalize the four phases of cognitive presence, Garrison et al. (2001) developed a set of descriptors and indicators to guide the qualitative coding of the transcripts of students’ discourse.

Through analysis of extensive transcripts of students’ online discussion, Garrison and his colleagues (2001) identified the indicators of each phase of cognitive presence as shown in Table 1. The socio-cognitive processes column in Table 1 are the examples of students’ behaviors that exemplify the indicators.

Descriptors have described the most important characteristic of each phase. Triggering Event is described as “evocative” or “inductive” to emphasize the directing of attention and

recognition of a problem. Exploration is “inquisitive” and “divergent,” indicating thinking toward different directions in the inquiry. Integration is “tentative” and “convergent,” representing students’ attempts to integrate information and propose a tentative solution. Resolution is assigned “committed” and “deductive” to reflect the dedication to achieve a logically certain conclusion through reasoning and empirical testing.

Table 1: PI coding scheme

Phase	Descriptor	Indicator	Socio-cognitive process
Triggering Event	Evocative (inductive)	Recognize problem	Presenting background information that culminates in a question
		Puzzlement	Asking questions; Messages that take discussion in new direction
Exploration	Inquisitive (divergent)	Divergence	Unsubstantiated contradiction of previous ideas; Many different ideas/themes presented in one message
		Information exchange	Personal narratives, descriptions, facts (not used as evidence to support a conclusion)
		Suggestions	Author explicitly characterizes message as exploration—e.g., "Does that seem about right?"
		Brainstorming	Adds to established points but does not systematically defend/justify/develop addition
		Intuitive leaps	Offers unsupported opinions
Integration	Tentative (convergent)	Convergence	Reference to previous message followed by substantiated agreement, e.g., "I agree because..."; Building on, adding to others' ideas Justified; Justified, developed, defensible, yet tentative hypotheses

		Synthesis	Integrating information from various sources-textbook, articles, personal experience
		Solution	Explicit characterization of message as a solution by participant
Resolution	Committed (deductive)	Apply	
		Test	
		Defend	

In addition to the coding scheme, the 12 items in the CoI survey are an instrument to quantitatively assess students' cognitive presence (Arbaugh & Cleveland-Innes, 2008).

Application of PI model. Much of the early literature on the PI model has investigated the distribution pattern of cognitive presence in text-based asynchronous online discussion (e.g., Garrison, et al, 2001; Meyer, 2003; McKlin, et al., 2001, Panwan et al.2003, Vaughan, et al., 2005). These studies revealed a pattern in common that students display less Resolution and Integration, and Exploration is the dominant phase during their inquiry process. Garrison et al. (2001) provided a possible reason for this phenomenon, and they assumed that students tend to stay in their comfort zone by not leaving the Exploration phase since Integration and Resolution are more intellectually demanding. Akyol and Garrison's (2011) recent study suggested that this pattern can be changed by instructional design. They found that when more project opportunities were provided for applying solution ideas (i.e., develop a prototype), Integration was improved greatly and achieved the highest percentage among the four phases.

Several attempts have been made to apply the PI model to analyze various aspects of deep learning and higher order thinking in students' discourse. McLoughlin & Mynard (2009) and Meyer (2003) analyzed students' online discussion and found that the PI model was effective to find the evidence of higher order thinking. de Leng et al. (2009) and Guldberg and Pilkington (2014) measured students' critical thinking in understanding subject concepts and evaluated the

effectiveness of instructional techniques/models. Stein et al. (2007) tracked students' cognitive presence over time to reveal how shared understanding is formed and developed in synchronous online chat. Schrire (2006) and Celentin (2007) used PI to help analyze how the interaction among students lead to the building of new knowledge and design of new solutions. Koh et al. (2010) used PI as a knowledge construction model to guide their study on students' knowledge construction in project-based learning. Morueta et al. (2016) assessed students' cognitive presence to understand their learning process when performing complex cognitive tasks such as a case study and product creating & evaluation.

In recent years, there has been an increasing amount of literature on adopting the PI model in different learning environments to help understand students' learning process in these settings. In examining how pre-service teachers develop their teacher skills, Taddei and Budhai (2016) used the PI model to measure these pre-service teachers' critical thinking in the voice-recorded reflections on their service provided to young children. Asoodar et al. (2014) and Popescu (2016) investigated students' cognitive presence in their blog conversations. Akyol and Garrison (2011, a) studied the pattern of cognitive presence in the courses that blended face-to-face class with online sessions. Guided by the PI model, Pellas and Kazanidis (2012) developed a 3D virtual learning environment that was designed to support the progression of students' cognitive presence. McKerlich et al. (2011) applied the PI model to students' synchronous activities in a 3D virtual environment. They adapted this model to their situation by adding a few indicators such as integrated education tools, use of enhanced multi-media, and mediated assessment. Compared to most research that applied the PI model in analyzing discussion transcripts, Yang (2016) applied the PI model in analyzing various textual data that were generated by preservice teachers, such as the feedback, action logs in three presences,

observation notes on peers' work, and transcripts of asynchronous discussion and synchronous chat.

Cognitive Presence Overtime

There is a consensus among researchers that learning has significant temporal dimension (Anderson, et al., 1989; Bloome, 2009; Brooks, et al., 2015; Chiu, 2008; Cobb, 1999; Compton-Lilly, 2013; Erickson, 1996; Mercer, 2008; Roth, 2001; Wells, 1999). Learning develops over time, and the process is so "inherently sequential" that it cannot be viewed as a series of discrete activities (Chiu, 2005, p.600). The temporal dimension of learning can provide important insight into "how learning happens and why certain learning outcomes result" (Mercer, 2008, p.35). The events that repeatedly happened can also help reveal the pattern of students' thinking progression (Compton-Lilly, 2013).

A few studies have attempted to investigate the temporal aspect of the process of creating and developing cognitive presence. Akyol and Garrison (2011) compared the cognitive presence evolvement pattern in asynchronous online discussion between online and blended courses. They divided the course semester into three time periods (three weeks per period), and then examined the percentage of the four phases of cognitive presence within each time period and compared the distribution pattern cross different time periods. Using the same time segmentation method, another study carried out by Akyol and Garrison (2008) paid particular attention to whether time produced significant effects on the four phases of cognitive presence, and how the time effects interacted with the phases effects. Their analysis showed that, within the same time period, the frequency difference among phases of cognitive presence is statistically significant. However, for each phase of cognitive presence, the change over time is not significant.

Stein et al. (2007) investigated the progression dynamics of cognitive presence in students' synchronous online chat. By coding teaching presence, social presence, and four phases of cognitive presence in students' chat transcripts, they transformed the conversation into a flow of codes. Based on the code flow, they particularly examined when each code occurs, the sequence of the codes, the codes repeated over time, and the duration of the codes. They observed a particular pattern of students using social and teaching presence to support their cognitive presence. Besides, their study provided evidence that students developed their cognitive presence toward Resolution in a non-liner way, but did not find any time effects on the pattern of the time allocation and learning strategy use when students worked through the cognitive presence progression.

Rather than looking at students' discourse in class, Chen and Koszalka (2015) investigated students' cognitive presence evolvement in journals that reflected on their instructional design practice. This study segmented the course semester into three periods: beginning, middle, and end (23-25 days per period). They tracked the change of cognitive presence across different periods, and found a pattern of the peak time for each cognitive presence phase: most Triggering Events and Exploration were observed at the beginning, Integration at the middle, and Resolution achieved the peak at the end. Their study reported significant changes over time for each phase of cognitive presence. Similarly, Cummings et al. (1995) analyzed students' collaborative essay writing in both face-to-face and computer-based modes by looking at the integration complexity students displayed in writing. They examined students' essays across six weeks, and found that students in computer-based writing groups showed higher degree of integration in the later weeks of the study.

Factors Associated with The Complexity of Cognitive Presence

The three constructs, teaching presence, social presence and cognitive presence, in the CoI framework provides satellite pictures that lead to "order and parsimony" in understanding the dynamics within an online learning community (Garrison, 2007, p.61). However, to obtain a satisfying view of how students develop their cognitive presence, pictures from microscopes are also needed (Dillenbourg, et al., 1995). Shea et al. (2014) pointed out that, the constructs in CoI are not adequate in fully explaining the phenomenon or pattern of students' behaviors and abilities that emerged in creating cognitive presence. No single viewpoint, instrument, or method can sufficiently reveal the complexity of the cognitive processes involved in creating the cognitive presence at different moments (Gunawardena, Lowe & Anderson, 1997; Schrire, 2006). The use of multiple theories, coding categories, and methods are necessary in analyzing the complex process (Schrire, 2006; Sherry, et al., 2000).

Therefore, to characterize students' cognitive presence at a fine grain, several other dimensions that help reveal the sophistication of creating and developing cognitive presence were examined in the present study. In this section, I discussed these dimensions in terms of what they are, why they are worth studying, and how they have been studied in cognitive-presence-relevant research.

Engagement mode. In the Interactive-Constructive-Active-Passive (ICAP) framework, Chi (2009) explicitly defined four modes of cognitive engagement: passive, active, constructive, and interactive. Rather than focusing on the phases of learning and inquiry, the ICAP framework examines "the amount of cognitive engagement" that can be measured through students' overt behaviors (Chi & Wylie, 2014, p.219). According to Chi and Wylie (2014), being passive means "being oriented toward and receiving information from the instructional materials without

overtly doing anything else related to learning" (p.221). In this process, students passively receive information, such as watching a video without taking notes. Being active means "doing something physically" (Chi, 2009, p.77), such as underline or highlight, paraphrase, repeat. It involves an "attending" process of focusing attention, activating prior knowledge and assimilating new information. Being constructive refers to individually generating outputs (e.g., ideas, artifacts) that go beyond the presented learning materials, such as explain, connect, generate hypothesis. This is a "creating" process in which students build, integrate, or organize knowledge. Being interactive means being constructive in a dialoguing way. There are two criteria for defining this "jointly creating" process: 1) in the dialogue, the engagement of both partners should achieve constructive level; 2) they construct through building on/with others' contributions. For example, students modify their ideas based on peers' feedback, debate with others, or develop ideas based on others' contribution.

ICAP assumed that the interactive mode achieves the greatest level of engagement, followed with constructive, active, and passive modes. Chi and Wylie (2014) validated this hypothesis by both conducting studies and examining in literature the empirical studies that used learning activities of different modes. They found hundreds of studies supported this hypothesized order of engagement level. ICAP provided the dimensions to look at to what extent students engaged into learning. Fonseca and Chi (2011), Deiglmayr et al. (2015), Wang et al. (2016), and Chi and Kang (2016) used the categories in ICAP in their studies and found this framework was effective in differentiating students' level of engagement in class discourse. ICAP framework was originally developed for students' learning in traditional classroom. Wang and her colleagues (2016) adapted this framework to the context of online discussion by identifying the students' overt behaviors that represent each mode of engagement.

In this dissertation study, the four modes proposed by ICAP were used to help look into each phase of cognitive presence, and to examine specifically at which level students engaged in Triggering Event, Exploration, Integration, and Resolution during their inquiry.

Social network pattern. In a community of inquiry, students not only participate, but also interact. To learn and inquire, the associated cognitive and the social process are inevitably linked (Vygotsky, 1978). The cognitive processes involved in creating cognitive presence "arise out of, and contribute to, the interactions among the participants" (Schrire, 2006, p.53). In this sense, cognitive presence is a social product of going through various degrees of social interaction and collectivity. The CoI framework itself also supports such a relationship, and suggests researchers, in studying cognitive presence, situate cognitive presence in the social activities carried on by the community of learners (Garrison, et al., 2000).

A social network is a network of participants who are tied by social relations (Nandi, et al., 2012). The relations could be in the form of information flow, collaboration, friendship, or citation (Rabbany, et al., 2014). In this network, each participant is represented as a node, and the relation between any two participants is represented as a link/tie (Wasserman & Faust, 1997). The structure and composition of these links/ties and the positions of these nodes depict the pattern of the social interactions among community members. Besides the straightforward visual representation of the network, the network metrics can reveal the network characteristics that cannot be easily observed from the network graph. Centrality and density are two important metrics. Centrality measures the number of connections a student makes with others, while density measures the overall number of connections in a network (Scott & Carrington, 2011).

It has been found that social interaction pattern was associated students' behavior, attitude, and performance in higher order learning, the level of learning that CoI framework has

focused on (Shea et al., 2014). For example, studies on the community of learning have applied the analysis of the social network pattern in the investigation of students' collective knowledge construction (Aviv, et al., 2003; De Laat et al., 2007; Oshima, et al., 2012; Zhang, et al., 2009), critical thinking (Aviv, et al., 2003; Thormann, et al., 2013), cognitive engagement (Zhu, 2006), learning performance in terms of course grades (Cho, et al., 2007; Dawson, 2010), sense of community (Dawson, 2008; Shen, et al., 2008), self-regulation behavior (Lin, et al., 2015), and students' self-esteem and satisfaction (Yu, et al., 2010).

To get a holistic view of students' knowledge building in forum discussion, Schrire, S. (2006) combined the content analysis of students' cognitive presence with the analysis of the social network pattern. By comparing the graphs of students' social network, she identified different patterns of interaction in students' discourse: instructor-centered, synergistic, and scattered. She also found the interaction pattern was associated with the phases of students' cognitive presence—students showed more Exploration in the instructor-centered pattern, in which most interactions occur between students and the instructor, and more Integration and Resolution in the synergistic pattern, where most interactions take place among students. She commented that incorporating social interaction analysis in studying the cognitive dimension "contributed to an understanding of how the knowledge building process had taken place…and allowed the study to move from the level of description to the level of interpretation" (p.64).

Shea et al. (2014) conducted the analysis of students' social networks in studying the knowledge construction mechanism articulated in CoI framework. They examined how the occurrence of cognitive presence was related with students' positions in their social network. The data showed that the students who displayed more cognitive presence were more likely to be near the center of the network. Besides the network graph, they also looked at some network

metrics such as centrality, prestige and influence by calculating the number of incoming and outgoing responses. They found that students' cognitive presence was significantly correlated with these network metrics.

De Laat et al. (2007) integrated social network analysis with content analysis to study the discourse dynamics within a community of learning. They traced the evolvement of students' participatory pattern by comparing the interaction pattern graphs, and analyzing the network density and centrality at the beginning, middle, and end phases of the learning and tutoring process. In this study, they concluded that social network analysis is "a valuable complementary analytical tool" as they can visualize and illustrate the social nature of group learning (e.g., forming of groups, group cohesion, role changes, activeness of students) in a way that can hardly be achieved by content analysis of students' messages (p.101).

Ways of idea collaboration. Among all the social interactions taking place in a community, Kanuka et al. (2004) pointed out that collaboration on the idea level is an important factor that lead to the development of cognitive presence. They defined idea collaboration as "the use of interactive participation learning strategies to facilitate active intellectual participation" (p.28). Hmelo-Silver and Barrows (2008) listed several means of collaboration that facilitate students' cognitive development. These moves are: introducing new ideas, modifying previous ideas, agreement, disagreement, and meta monitoring of individual or group progress. In their study, they used these categories to code students' discussion transcripts and found they were effective in revealing the mechanism of students' knowledge construction.

Constructive use of resources. The constructive use of resources is a factor emphasized by Scardamalia (2012) in understanding the cognition involved in building knowledge in a learning community. She stated that the resources include both the authoritative resource from

experts, books, the internet, or teachers, and the local resources from students' present observations or the recall of prior experience.

Students' use of these resources can be an important indicator of students' learning. According to Dewey (1933), the local resources (e.g., observations, experience) are crucial in students' reflective activities. He considered the local resources as empirical data, which students use to both develop and evaluate their inferences. Thus, examining whether/how students use the local resources can help to better understand the important activities such as formation and evaluation of ideas in creating cognitive presence. Besides the use of local resources, Zhang et al. (2007) pointed out that what stance students take toward the authoritative resources, and in what way they use them, can reveal whether students' cognitive level stays at the information retelling level or meaning making level.

In Zhang et al.'s (2007) study, they employed several coding categories to examine students' use of both the local resources and the authoritative resources. The categories they used included: report experiment results, report observations or recall past experience, rephrase or summarize information from expert sources, and the use of expert resources to aid/advance personal ideas and understandings.

Linguistic features. Students construct meaning and convey ideas by purposefully selecting and organizing words, phrases, sentences, or texts (Von Glaserfield, 1989). Words contain psychological meanings: the use of words reflects what people think about, what is the focus of their attention, or how they feel (Tausczik & Pennebaker, 2010). In recent years, to understand psychological facets of their discourse, besides the content analysis of students' statements in specific contexts, researchers made alternative attempts to examine the linguistic features of students' utterances through the statistics analysis of word use.

Word count-LIWC. Word count was commonly taken as a supplementary indicator of the cognition complexity displayed in students' writing in online discussion (e.g., Schrire, 2006). The evidence presented in some recent studies supported this hypothesis. For example, Kovanovic et al. (2016) reported that students who wrote longer messages were more likely to achieve the Integration and Resolution phases of cognitive presence. Chen and her colleagues (2016) also found that the word count of students' journals was significantly associated with the grades that were given based on the level of thinking they demonstrated in their reflections. In an analysis of the relationship between linguistics speech features and users' cognitive loads they have experienced in tasks, Khawaja et al. (2009) found that the number of words spoken by users increased greatly as the cognitive load level increased.

Pennebaker et al. (2003) proposed a psychological word count approach for the detailed examination of word use in speech data. In this approach, they created a dictionary of psychologically relevant words and then grouped these words into 90 linguistic and psychological dimensions. They then developed Linguistic Inquiry and Word Count (LIWC) software to support the linguistic analysis by calculating the percentage of the words use in these dimensions. Generally, LIWC word categories include summary language variables (e.g,. analytical thinking, emotional tone), general descriptor categories (e.g., words per sentence, words that are longer than six letters), linguistic dimensions (e.g., words that are pronouns, articles, auxiliary verbs, etc.), psychological constructs (e.g., cognition, affection, biological processes, motivation), personal concern categories (e.g., work, home, leisure activities), informal language markers (e.g., assents, netspeak), and punctuation categories (e.g., periods, commas) (Pennebaker, et al., 2015). The validity of these word categories has been supported by hundreds of studies on psychological processes (Tausczik, et al., 2010). An experiment

conducted by Pennebaker and Francis (1996) tested the validity of LIWC. The results of analyzing 72 college students' essays suggested that LIWC is valid in measuring emotions, cognitive strategies, thematic content, and different language composition elements.

LIWC can support the research on cognition by its ability to capture the clues of the depth and complexity of thinking (Tausczik, et al., 2010). According to Tetlock (1983), cognitive complexity is reflected through taking into account different dimensions of a problem (differentiation) and developing connections among these dimensions (integration). The two aspects are covered by the word categories in LIWC. For example, people might use Differentiation (e.g., hasn't, but, else) and Preposition (e.g., to, with, above) words to make distinctions or give details, or use Conjunction (e.g., and, also, although), Causation (e.g., because, effect), and Comparison (e.g., greater, best, after) words to connect and organize thoughts (Boals & Klein, 2005; Graesser, et al., 2004; Hartley, et al., 2003; Newman et al., 2003; Pennebaker, et al., 2005). The Insight words (e.g., think, know) and the words that are longer than six letters can help reveal some information about the cognitive process (Hartley, et al., 2003; Pennebaker, et al., 1997). The words indicative of people's certainty, such as Discrepancy (e.g., should, would), Tentative (e.g., maybe, perhaps), and Certainty (e.g., always, never) can reveal, to some extent, how certain people are about a topic or at which level people have formed or processed their ideas (Beaudreau, et al., 2006; Carroll, 2007; Tausczik, et al., 2010).

Since research has shown the interdependence between word use and cognitive process, LIWC has been used as a supportive analytic tool in a number of studies to analyze students' thinking and learning. For example, Kennison (2003), Peden & Carroll (2008), and Carroll (2007) investigated the use of the cognitive words in students' writing to analyze their critical thinking, reflective thinking, and cognitive growth. Khawaja et al. (2012) found the linguistic

features in LIWC were effective in measuring the cognitive load involved in collaborative communications. Williams and D'Mello (2010) examined the conceptual quality of students' responses to a tutor's questions by looking at the pronouns and cognitive words. By focusing on the linguistic, cognitive, and emotion categories covered by LIWC, Yoo and Kim (2012) analyzed students' online discussion and used these categories to predict students' performance in the course projects. Pier et al. (2014) found the statistically significant relationship between different linguistic variables (e.g., pronoun, verb tense, Insight words, Discrepancy words) and the quality of the mathematical arguments made by students. Worsley and Blikstein (2010) used the word categories in LIWC to help compare the characteristics of expertise between experts and novices.

In some of the latest studies on cognitive presence, researchers started to use LIWC to support the linguistic analysis of the psychological aspects of students' discussion. Joksimovic et al. (2014) adopted LIWC in studying the psychological characteristics of students' cognitive presence in online discussion. Their analysis showed that the word categories, such as word count, auxiliary verbs, tentative words, filler words, causal words, differentiation words, and discrepancy words can be viable indicators of different phases of cognitive presence. Since Joksimovic et al. (2014)'s study found the association between cognitive presence and LIWC word categories, Waters et al. (2015) and Kovanovic et al. (2016) then extracted the linguistic variables provided by LIWC and developed a classification system that can perform automated content analysis of students' online discussion in terms of the phases of cognitive presence. Elouazizi (2014) also hypothesized that if students are actively engaged in a community of inquiry, their use of some word categories (e.g., cognitive words, perceptual words, certainty

words) will be high. He used these word categories in LIWC as the indicators of cognitive presence, and explored the characteristics of students' learning and inquiry in MOOCs.

Facilitation

Facilitation

Cognitive presence does not occur in isolation, and facilitation plays an important role in creating, maintaining, and developing it (Garrison, 2003). According to Chi et al. (2001), facilitation refers to the interventions that push students further along in their line of thinking. In this sense, a facilitator is more like a "process expert" than a "content expert" (Zhang et al., 2011). Garrison and Anderson (2003) pointed out that, as the "process expert" in a community of inquiry, the facilitator needs to focus on managing the discourse process and monitoring the depth of thought. In this process, the function of facilitating involves "questioning, searching for key concepts, making connections, injection of new ideas or concepts, constructing frameworks, diagnosis of misconceptions, and reviewing and summarizing" (Garrison & Anderson, 2003, p.86).

Facilitation of Cognitive Presence

Several attempts have been made to study the facilitation of cognitive presence. Different strategies have been explored and recommended in a number of studies to trigger, maintain, or develop cognitive presence, such as role assignment (Darabi et al., 2011; Kalelioglu & Gülbahar, 2014; Olesova, 2016), posing debate topics (Darabi et al., 2011; Kanuka et al., 2007; Richardson et al., 2010), introducing cases and stories (Richardson et al., 2010), brainstorming (Kalelioglu & Gülbahar, 2014), inviting experts (Kanuka et al., 2007), and reflection practice (Kanuka et al., 2007; Taddei & Budhai, 2016). Since much previous work has reported the common pattern that students were less likely to move to the later phases of cognitive presence-Integration and

Resolution (e.g., Garrison, et al, 2001; Koh, et al., 2010; Popescu, 2016; Vaughan, et al., 2005), most research turned attention to the facilitation strategies and practices that can stimulate more Integration and Resolution. Though limited to no studies have reported the evidence that can confirm the hierarchical relationship among the four phases of cognitive presence, researchers tend to consider the later phases as the higher level of cognitive presence (e.g., Kalelioglu & Gülbahar, 2014; Kozan, 2016; Shea & Bidjeran, 2010; Stein et al., 2013)

One area of interest for researchers is to compare the different discussion strategies in facilitating cognitive presence. Richardson et al. (2010) examined case-based discussion, debate, and open-ended discussion. They found that more students achieved the later phases of cognitive presence (Integration, Resolution) in the case-based discussion and debate. They also noticed that students created more solutions in case-based discussion, and more synthesis in debate and open discussion. Similarly, Kanuka et al. (2007) compared five facilitation approaches: debate, invite expert, Webquest-based inquiry, brainstorming on a well-formed question, and reflective deliberation where students critically reflect on learning materials. The results showed that students in Webquest-based inquiry and debate attained more later occurring phases of cognitive presence. In comparing different discussion strategies, Darabi et al. (2011) situated students in authentic scenarios. They investigated the contribution of debate, role-play, structured discussion where students were provided prompts that prescribed the difficulties they would encounter, and scaffolding discussion where students were facilitated by a series of probing questions. Their analysis revealed the association between these strategies and cognitive presence. They found that the structured approach significantly correlated with Triggering Event, scaffolding strategy correlated with Resolution, and debate and role-play were related with Exploration and Integration. Olesova (2016) examined the effects of different scripted roles (e.g., starter, skeptic,

wrapper). She found that all three roles were effective in facilitating students' cognitive presence. Her study reported the cognitive presence distribution for different roles, and the results showed that there existed significant difference between the types of roles and the level of cognitive presence.

Compared to these studies, Kalelioglu and Gülbahar (2014) also examined the combined use of different strategies. Their strategies included: brainstorming; role-play (e.g., administrator, teacher, student); Socratic seminar, where students were required to ask questions in a critical way; Anyone Here an Expert, where students were assigned different specialties (e.g., programmer, instructional designer, subject expert); and Six Thinking Hats, where each student was assigned a perspective and then all the students came together and shared ideas from different perspectives. They divided students into six groups. Among them, five groups employed a particular discussion strategy, and one group adopted all five strategies. They found that the mixed group achieved more later phases of cognitive presence than the other groups.

Some researchers turned their attention from selecting and designing the format of discussion to the facilitation practice during the process of discussion. For example, in Arnold et al.'s (2006) study on cognitive presence, they facilitated students with guidelines on discussion that explicitly explained the use of reasoning, personal experience, diverse perspectives, theoretical knowledge, and connection between theories. They also provided immediate feedback on students' cognitive and social performance. To enhance students' self-regulation, Gašević at al. (2015) provided students with guidance on the cognitive questions they can ask (e.g., questions for clarification/synthesis/innovation), and assigned students different roles in source searching, theorizing, summarizing, moderating, and topic leading. They found both question

guidance and role assignment produced significant effects on students' cognitive presence, and the combined use of both strategies resulted in significantly more later-phase cognitive presence.

Stein et al. (2013) took into account the dimension of time, and examined the facilitation over time. Their facilitation combined coaching and feedback. In coaching, students were trained on discussion strategies such as summarizing, questioning, building arguments on evidence, achieving consensus, and using cohesive language (e.g., "we", "us", "our"). Immediate feedback was given to students on what they did right in using these discussion strategies to make an argument. Their results showed that, neither intervention by itself or time by itself produced an effect on students' cognitive presence. The interaction between time and facilitation was significant. When students received continuous coaching and feedback, they showed more of both total and later-phase cognitive presence.

Some other researchers proposed their model of facilitation by grounding in literature or a particular theory. For example, based on the activity theory, Wang and Chen (2008) proposed an activity system and several design principles that aimed to facilitate cognitive presence in university courses. They reported that the design elements they developed helped students achieve more total cognitive presence and the Integration phase of cognitive presence. Similarly, Stein and Wanstreet (2012) proposed a guide for coaching cognitive presence by combining the CoI framework (Garrison & Anderson, 2003) with elements of the Co-active coaching model (Whitworth, et al., 1998). In this guide, they also recommended a series of coaching activities that corresponded to the three aspects of teaching presence: design/organization, facilitation, and direct instruction. Through literature review, deNoyelles et al. (2014) summarized the facilitation strategies that had been supported by previous empirical studies, and then corresponded these strategies with the three presences in CoI framework. The strategies they identified include

questioning, challenging stance, modeling of social cues, feedback, peer facilitation, required or graded discussion, and project/problem/debate/protocol prompts.

Facilitation Techniques

Facilitation techniques of AOD refer to the specific intellectual, social, and organizational strategies that can promote the discussion quality (Cifuentes, et al., 1997; Hew, 2015). Facilitation techniques are the strategies, at the micro level, that focus on the particular actions or moves the facilitators take in the emerging process of discussion. In the area of facilitating cognitive presence, most of the aforementioned approaches or practices, at a macro level, have paid attention to the format and organization of discussion, such as the case-based discussion, inviting expert, role assignment, or brainstorming. Relatively few attempts have been made to investigate the role of facilitation techniques in developing students' cognitive presence. The present study explored the use of these techniques in promoting cognitive presence, which was identified from the discussion data. In this section, I discuss the definition of each type of facilitation technique, the role of that technique in students' discussion, and the literature that can support the validity of these techniques.

Questioning. Questioning is a technique in which instructors/facilitators ask questions to give students opportunity and responsibility to think (van Zee & Minstrell, 1997). Question asking is an integral part of learning. In structuring class discourse, a facilitator's contribution largely lies in asking questions rather than giving information (Chi, et al., 2001; Graesser & Person, 1994; Hmelo-Silver, et al., 2008; Hogan et al.,1999; Merrill et al., 1995), and the questions asked by a teacher/facilitator can be an important indicator of the teaching/facilitation quality (Carlsen, 1993; Roth, 1996; Smith, et al., 1993).

Questions from the facilitator benefit students in many ways. For example, the questions can help activate prior knowledge and set learning goals (Hmelo-Silver & Barrows, 2008); elicit missing information and locate the knowledge deficit (Hmelo-Silver & Barrows, 2008; Roth, 1996); provoke critical, reflective, or creative thinking (Graesser, et al., 2002; King, 1994; van Zee & Minstrell, 1997); let students take on the responsibility in constructing knowledge (Chi, et al., 1994); stimulate and shape the development of discourse (Polman, 2000); monitor students' on-going conceptual understanding and group consensus evolvement (van Zee, et al., 2001); focus discussion attention on critical issues (Roth, 1996); manage the social situation (Lemke, 1990); and scaffold the decision making that leads students to the problem's solution (Roth, 1996).

However, not all the questions are equivalent in the ability to guide students' thinking, and different types of questions lead to different kinds of reasoning (Graesser & Person, 1994). Much of the literature in educational psychology categorize questions in class into higher and lower cognitive types (e.g., Ghee, 1976; Martikean, 1973; Millett, 1968). Higher cognitive questions require students' to mentally manipulate the previously learned information to generate or support an idea with "logically reasoned evidences", which involves inference, application, analysis, synthesis, or evaluation (Winne, 1979). Yet lower cognitive questions expect students to recall or retell factual information that was previously presented to them, which is accompanied by memorizing or comprehension (Redfield & Rousseau, 1981). Graesser and Person (1994) pointed out that the higher cognitive questions that request deep explanation are a role model of good questioning. It has conclusively been shown in several research studies that they are associated with higher-level of thinking and learning (e.g., Graesser & Person, 1994; Hakkarainen, 2002; Hmelo-Silver & Barrows, 2008; King, 1999). Redfield and Rousseau (1981)

conducted a meta-analysis of the literature on fourteen experimental studies of teachers' questioning behaviors. They confirmed that use of higher cognitive questions has a significantly positive effect on students' learning achievement. In contrast, lower cognitive questions are more likely to be effective in facts-telling learning tasks, but less effective in deep learning that involves idea integration, knowledge building, and problem solving (King, 2007).

Therefore, based on Winne's (1979) definition, the present study considered the questions that drive explanation or finding evidence from life experience as the higher cognitive questions. These questions are concerned with "Why?", "How?", "What if?", and "What if not?" (Graesser, et al., 2002, p.37). Besides the cognitive questions, the questions that address the social coordination aspect (e.g., check joint understanding) are also important in developing the collective responsibility among students in the process of knowledge construction (Hmelo-Silver & Barrows, 2008).

Making clarification. Making clarification is a technique in which facilitators support students' statements by providing explanation that tells "why" and "how", or elaborating on a topic that involves "adding details, giving examples, generating images, and in general relating the new material to what is already known" (King, 1997; King, 2007, p.21; Gao, 2014). Explaining and elaborating is traditionally a commonly used way for teachers, tutors, or facilitators to convey key information to enrich students' understanding of key concepts or issues (Roscoe & Chi, 2007).

Roscoe and Chi (2008) recommended two strategies that can make clarification more effective. The first one is the use of analogy to make abstract ideas concrete and easier to understand. Analogy is comparing between similar situations to "make the unfamiliar familiar," which serves as an important instructional device in constructing explanations to students (Duit,

1991, p.651; Gentner & Holyoak, 1997). The analogical similarities facilitate conceptual change by making explicit the key features of a concept or the relationship among concepts (Duit, 1991). It also helps learning in the way that students can link the novel situation to, and construct the new understanding upon, their prior knowledge (Black & Solomon, 1987). The empirical research on the role of analogy in teaching supported the effectiveness of analogy use in facilitating learning and problem solving (e.g., Capon & Kuhn, 2010; Duit, et al., 2001; Gentner & Gentner, 1983; Glynn, 1989).

The other is the use of examples in demonstrating the complexity of a procedure or a situation. An example is "an instance of a concept" rather than comparing similarities between concepts (Glynn et al., 1989. p. 385). It serves a similar purpose as analogy to ease understanding and reduce cognitive load (Sweller, 1988). Research found that students preferred examples to verbal/textual explanation of a phenomenon or a procedure in problem solving or learning new materials (Anderson, et al., 1984; Recker & Pirolli, 1995; VanLehn, 1986). Detailed examination of the effectiveness of examples showed that examples are related with initial stages of skill development (Atkinson et al., 2000; VanLehn, 1996), and students achieved deeper understanding and learned more efficiently when provided examples (Atkinson, et al., 2003; Zhu & Simon, 1987; Ward & Sweller, 1990).

In addition to the strategies mentioned above, Duit (1991) recognized that visual aids, such as pictures and diagrams, function similarly to analogy in facilitating the communication of ideas and concepts. Studies by Dreistadt (1969), Royer & Cable (1976), Shapiro (1986), Bassano & Christison (1995), Gan (2008), and Chuy et al. (2011) confirmed the effectiveness of visuals in supporting problem solving and knowledge building.

Promoting connection. In promoting connection, facilitators make connection or help students develop the connection to other pieces of discussion, resources, or arguments (Gao, 2014). Learning is fundamentally about constructing connections. In order to learn, students develop many schemata in mind that organize ideas and concepts into "a meaningful system of relationships" (Cross, 1999, p.8).

Cross (1999) identified two types of connections that can facilitate learning. One is linking new knowledge with prior knowledge, and the other is connecting new learning with personal experience. When students relate learning with existing prior knowledge or personal experience, learning tends to become easier as they construct understanding upon what they are familiar with (Caine & Caine, 1991; O'keefe & Nadel, 1978). This assumption has been validated by the experiment conducted by de Groot (1966). Adding to this, learning becomes more meaningful by doing so since students process learning materials from a broader view that they can see how the new knowledge can explain or solve the problems in the real world (King, 1994). Thus, researchers recommend the use of facilitative prompts or cues in class conversation to encourage such connections (King, 1994; Pressley et al., 1992; Perkins & Salomon, 1989).

Besides the connection to prior knowledge or experience, other connections that benefit students' learning have been discussed in literature. For example, King's (1994) study showed that creating connections among different ideas within a lesson also have significant effect in enhancing learning. His study indicated that when the prompts/cues used call for the connection among different aspects of the lesson, students were more likely to engage in complex knowledge construction. Moore (1993) pointed out that, in developing an argumentative discourse, referring to prior discourse is a strategy to help develop the explanative statements and interpret others' contribution. Abrams's (2003) study suggested that when students were

encouraged to explicitly connect to previous discussion, the cohesion of class discussion was enhanced and students showed more sophisticated communication skills that lead to quality learning.

Summarizing and revoicing. Summarizing is a strategy facilitators use to compile, synthesize or paraphrase students' ideas up to the current point to distill the most important aspects of the discussion (Hung, et al., 1998). The summarizing can integrate the discussion (Hara et al. 2000) and thus can help keep the discussion focused (MacKnight, 2000; Rovai, 2007). According to Hew et al. (2010), summarizing of the on-going discussion allows students to easily go through the major points and essential ideas. This can help reduce information overload or the repetition of same discussion content. Also, the summary of the discussion is a reflection opportunity for students to revisit the existing ideas, clarify the unclear ideas, and pursue the topic further (Hew et al., 2010; Hung, et al., 1998; Lim & Cheah, 2003). Hmelo-Silver and Barrows (2006) also found that, in problem-based discussion, summarizing students' discussion was a good strategy to create joint representation of the problem, based on which, students then developed their shared understanding during the negotiation.

Revoicing is a summary strategy of restating students' opinions through repeating or paraphrasing to emphasize the important points raised in the discussion (Hmelo-Silver & Barrows, 2006; Zhang, et al., 2011). This strategy has been found to be useful in facilitating class discourse in several studies (e.g., Chin, 2006; Hmelo-Silver & Barrows, 2006; Koschmann, et al., 1999; O'Connor&Michaels, 1993; Zhang, et al., 2011). By restating students' ideas, the facilitators can mark the important and promising contributions, and this is likely to suggest a more productive direction for the discussion (Hmelo-Silver, et al., 2006). Zhang et al. (2011) suggested that revoicing can serve as a strategy to help ensure students' shared understanding

and clarify the unclear ideas in discussion. Chin (2006) and Hmelo-Silver & Barrows (2006) also pointed out that repeating the ideas from less vocal students can encourage them to engage with the discussion and continue to contribute.

Providing information. Providing information is a technique that facilitators use to share personal opinions or experiences, pose new ideas, and introduce relevant resources (Hew & Cheung, 2008; Kennedy & Kennedy, 2010). Hew and Cheung's (2008) study revealed that this was one of the most frequently used strategies by facilitators in AOD, especially when responding to particular students. They suggested this strategy can help prevent the discussion threads from dying, get students involved through giving personal opinions to their points, and minimize the psychological distance between facilitators and students when they see that facilitators have similar/relevant experiences like them.

A certain number of postings are needed for a discussion before moving to a higher level of knowledge construction (Schellens et al., 2005). In a later study, Hew and Cheung (2011) found that this strategy served this purpose. Facilitators' contribution functioned as a starting point that students can build upon. And keeping discussion alive and progressing makes possible the higher-level construction. Kennedy (2004) agreed with this conclusion. He posited that giving information is a "fundamental move" of a facilitator that may trigger new directions of thinking, and bring promising ideas or important resources into group awareness (Kennedy, 2004). Also, providing additional resources and information when needed can scaffold students in developing their ideas and constructing new knowledge (Kobbe, et al., 2007).

Sharing their knowledge and experience on the discussed topic is a part of facilitators' responsibilities. According to Kennedy & Kennedy (2010), in a community of learning, beside

the facilitating and guiding role, the facilitators also play the role of "co-inquirer" with students in contributing new ideas or resources to the development of community knowledge.

Using positive social cues. In AOD, social cues are the words or symbols in texts that reflect personal feelings and emotions (Chen & Chiu, 2008; Walther & D'Addario, 2001). Positive social cues are the words or symbols that demonstrate positive feelings and can develop positive personal relationships, such as to show appreciations (Hew & Cheung, 2011) or compliments (Chen & Chiu, 2008), express agreement or shared understanding (Schwarz et al., 2007), and invite students to contribute (Hew & Cheung, 2008).

Positive social cues are important in both increasing the trust level among community members and creating/maintaining strong social ties in online communication (Whitty & Gavin, 2001). Students are more likely to share ideas and resources when such social ties are supported (Dawson, 2008). In online discussion that features limited physical connection, the paucity of social cues may lead to inactive students' involvement and reduced satisfaction toward the discussion experience (Russo & Campbell, 2004).

Hew and Cheung's (2011) study suggested that the use of positive social cues (showing appreciation, invite contribution) can minimize students' fear of having their ideas open to peer review and hesitation in challenging others' stands. Their data revealed that the social cues from facilitators made students feel that "they were worthy contributors" and their further contribution was expected and encouraged (p.316).

Despite the potential of using social cues in facilitating online discussion, researchers suggested to employ this technique in an appropriate and balanced way (Chen & Chiu, 2008; Hew & Cheung, 2011). Researchers questioned the usefulness of this technique by pointing out that too many social cues might distract students' attention from in-depth thinking to surface

social interaction (Hara, et al., 2000; Henri, 1992; Walther, 1996). Hew and Cheung (2011) also found that the social cues of showing appreciation and praise became less effective when facilitators used them for almost every student without pointing out why and how their input contributed to the collective knowledge construction.

Peer Facilitation

Peer facilitation has been suggested as an effective strategy to facilitate the creation of a community of inquiry and the development of students' cognitive presence (Garrison, 2003; Garrison & Akyol, 2013; Rourke & Anderson, 2002b; Shea, et al., 2014).

Although CoI framework initially emphasized the leadership role of teachers, Garrison et al. (2000) acknowledged that teaching presence can be "performed by anyone in a community of inquiry" (p. 89). In later studies, Garrison and his colleagues continued to find that when a formal instructor was not present, students were more engaged in the self-regulating of their cognitive presence (Garrison & Akyol, 2015). Thus, they recommended to let students take the lead in the discussion. Garrison and Akyol (2013) commented that "each participant not only has the responsibility to construct personal meaning but assume the role and responsibility to facilitate and direct that process individually and collaboratively …Without these co-responsibilities we simply do not have a community of learners" (p.85).

This study examined students' cognitive presence under the condition of peer facilitation. In this section, I discuss what peer facilitation is, and the practice and techniques of peer facilitation in current research.

What Is Peer Facilitation

The term peer facilitation has its origins in the context of school counseling (Anderson, 1976; Gumaer, 1973). It is a commonly used practice in discussion activities in group

counseling. Gumaer (1973) defined the peer facilitator as the person who is trained to facilitate others. He described peer facilitation as the behaviors and skills to "begin a small group discussion and to use the facilitating responses of clarifying, reflecting, and giving feedback. The child (facilitator) can encourage other group members to explore their ideas and feelings. The peer-facilitator can also help the counselor demonstrate concepts presented for discussion in the classroom." (p.4).

The pedagogical potential of peer facilitation was later recognized in supporting AOD; online educators started to involve students in facilitating the class discourse and experimented with peer facilitation (Harrington &Hathaway, 1998; Murphy, et al., 1996; Rourke & Anderson, 2002b; Tagg, 1994). When situated in online discussion, Oztok et al. (2016) considered it as a strategy to distribute responsibilities among a community of learning, and defined peer facilitation as the responsibilities of "initiating, sustaining, and summarizing" discussion (p.86). Hew and Cheung (2012) pointed out that peer facilitation involves both the same-age facilitation and the cross-age facilitation. In same-age facilitation, students from the same class facilitate the online discussion; while in the cross-age facilitation, senior students who are older or more experienced facilitate the discussion.

By employing peer facilitation, researchers found that students felt more comfortable in generating ideas and expressing opinions (Correia & Davis 2007; Hew, 2015), became more aware of their learning progress (Garrison & Akyol, 2015), and gained more skills and knowledge in facilitating discussion (Murphy et al., 1996). Besides, the facilitation from peers was more likely to increase students' participation rate (Tagg, 1994), improve the structure and cohesion of the discussion (Tagg, 1994), and encourage more higher level cognitive activities such as questioning (Rourke & Anderson, 2002b).

A few studies compared students' preferences between peer facilitation and instructor facilitation. Mixed findings were reported. Correia and Davis (2007) reported that the majority of students (62%) preferred peer facilitation in a small group. In contrast, Cheung & Hew (2010) and Hew (2015) found that, despite the pedagogical benefits of peer facilitation reported in literature, most students (65%) still preferred instructors to peers. By analyzing students' reasons for preferring instructor or peer facilitation, Hew (2015) suggested that the selection of facilitation methods depends on the purpose of the discussion. If the purpose of the discussion is to help students gain specialized knowledge on new topics or to achieve a consensus of opinions, they recommended instructor facilitation. If the purpose is to create an open environment to let students frankly exchange ideas, peer facilitation is recommended.

Peer Facilitation Practices

A number of studies have reported the practice of peer facilitation in discussion activities. Kear (2004) found that, in forum discussion, peer facilitation can naturally take place even without the instructor's intervention. Ioannou, et al. (2014) examined the naturally-emerged peer facilitation in online discussion. Their work showed that such peer facilitation was a crucial contributor to collaborative knowledge construction.

More researchers implemented peer facilitation in online discussion by assigning facilitative roles to the students from the same class (e.g., Hew & Cheung, 2008; Ng, et al., 2010; Rourke & Anderson, 2002b; Xie & Ke, 2011). Most of these studies reported positive results. For example, when peer facilitated, the overall participation in discussion increased (Poole, 2000), students posted more higher-quality posts (Seo, 2007), and the participation of student facilitators changed significantly in terms of quantity, diversity, and interaction attractiveness (Xie et al., 2014).

Some studies experimented with cross-age peer facilitation. De Wever et al. (2010) and De Smet et al. (2010) had fourth-year undergraduate students facilitate the discussion of first-year students. Their studies revealed that the facilitation significantly influenced the level of knowledge construction in discussion. Ruane and Lee (2016) developed the online discussion environment that allowed senior pre-service teachers to facilitate the novice in preparing to be teachers.

Other studies employed peer facilitation for a specific purpose. Ertmer et al. (2007), van der Pol et al. (2008), and Gielen et al. (2010) asked the student facilitator to review and give feedback on peers' work. McLuckie and Topping (2004) used peer facilitation as an assessment approach in discussion activity. Peer facilitation has also been used as a tutoring strategy in online learning activities (Cheng & Ku, 2009; Kester, et al., 2007; Thurston, et al., 2009; Topping, 1996; Topping, et al., 2013; Van Rosmalen, et al., 2008). Thurston, et al.'s (2009) study found that the tutee achieved more correct answers in the conversation when they were facilitated by peers.

The majority of the literature reported the practice of peer facilitation in online discussion in university classes. A few research studies examined the peer facilitation in other contexts such as nursing students' simulation practice (Curtis, et al., 2016), pre-service teachers' practical projects (Lockyer, et al., 2002), and science workshops (Micari, et al., 2005). There is a consensus among these studies that peer facilitation is effective in improving participants' engagement in these activities.

Despite the effectiveness that peer facilitation has demonstrated in different contexts, McLuckie and Topping (2004) pointed out that we should not expect the student facilitators to have or develop the necessary facilitating skills spontaneously. Peer facilitation needs the

guidance and scaffolding from the instructor to learn how to boost meaningful discussion (Correia & Baran, 2010; Cox, et al., 2004; Snyder & Dringus, 2014; Xie & Ke, 2011). The instructor could model the facilitation in the first few weeks (Gao, 2014), or provide students with guidelines on their responsibilities, or supply specific facilitation techniques (Correia & Baran, 2010). In this sense, the identification, clarification, and training of peer facilitation techniques is important in both improving the facilitation quality and enhancing students' learning in discussion (McLuckie & Topping, 2004).

Peer Facilitation Techniques

To scaffold the generation of facilitative questions, Choi et al. (2005) proposed a peer-questioning framework to help students facilitate peers' metacognition and learning. The framework provided guidelines on three types of facilitative questions: clarification or elaboration questions, counter-arguments questions, and context/perspective-oriented questions. They experimented with the framework and the results revealed that it was effective in increasing students' questioning behaviors in discussion, and that peers' questioning was an important contributor to students' reflection and knowledge construction. However, they did not find evidence that supported the direct causal relationship between the scaffolding and students' learning outcomes.

De Smet et al. (2008) conducted an empirical study that examined peer facilitators' use of facilitation techniques across different discussion themes and phases. They identified the techniques based on Salmon's (2000) e-moderating model that outlined five stages of facilitating. The techniques include: access and motivation (e.g., encouraging participating and wishing good luck), socialization (e.g., appreciating and confirming contributions; showing commitment), information exchange (e.g., give examples, personal views, and concepts; bringing

in other content information), knowledge construction (e.g., explaining the learning task; asking for explanation, clarification, summary; giving feedback, suggestion), and development (e.g., call for further reflection; elaboration; challenging students' ideas). From their data, they found a useful strategy is to use social/emotional communication in the first experience of helping a student. For example, they noticed that facilitators tend to show agreement or compliment students' work.

Chan et al. (2009) investigated the influence of facilitation techniques on the length of discussion thread. They coded the peer facilitation techniques using Hung et al.'s (1998) scaffolding framework that includes the techniques of questioning, summarizing, pointing (directing students in appropriate directions), and resolving (resolving differences and conflicts in opinions). They found that the use of summarizing and resolving, but without questioning at the initial stage of discussion, could lead to the early termination of the thread. They also found that the combination use of questioning with other techniques was more likely to increase the discussion continuity.

Compared to the studies that used an existing model to identify facilitation techniques, Baran and Correia (2009) identified the facilitation techniques through analyzing the data from peer-facilitated online discussion. In their article, they situated the techniques in the studied context and reported these techniques through detailed description of the cases of peer facilitation. The techniques they identified are: 1) highly structured facilitation that followed an organized process to keep discussion focused; 2) inspirational facilitation that emphasized students' personal goals and encouraged them to talk about their personal scenarios; 3) practice-oriented facilitation that encouraged constant connection to the practice and problem in real situations. In the narratives of the cases, they also mentioned the strategies including: asking

initiating questions that were related with students' real-life practices, asking probing questions, constantly responding to students' posts, providing examples or external resources, making explicit links to the reading material, encouraging students to discuss within their own context, synthesizing different ideas, and connecting current discussion to previous discussion.

Along this line, Ng et al. (2010) analyzed the discussion threads in multiple cases and revealed five peer facilitation techniques: questioning, challenging others' points, showing appreciation, considering others' viewpoints, and general invitation to contribute. Hew and Cheung (2008) analyzed the discussion thread that achieved six or more levels, and identified the techniques employed by peer facilitators in these threads. Their analysis revealed seven techniques: giving own opinions or experiences, questioning, showing appreciation, establishing ground rules, suggesting new direction, personally inviting people to contribute, and summarizing. Among them, questioning and sharing personal opinions or experiences were the most frequently used techniques. However, they did not determine the actual effects of the facilitation techniques on the discussion (e.g., length of the threads).

Ng et al. (2012) examined the use of peer facilitating techniques in discussion threads that demonstrated more knowledge construction occurrences. In their study, the facilitation techniques were adapted from Bonk and Kim's (1998) work. They did not let the re-established categories of techniques restrict their coding. The list of facilitation techniques evolved according to their data and new facilitation techniques were allowed to emerge. Their final version of peer facilitation techniques includes: challenging others' points, citing references, considering others' viewpoints, elaborating/clarifying, general invitation to contribute, giving personal opinion, personal invitation to contribute, questioning, setting focus for discussion, setting ground rules, showing appreciation, and synthesizing/summarizing. Among these

techniques, they found techniques such as challenging others' points, questioning, general invitation to contribute, considering others' viewpoints, and showing appreciation were used more frequently by peer facilitators in the threads that had more knowledge construction occurrences. However, they did not test the statistical significance of the difference.

Hew and Cheung (2011) analyzed the threads that demonstrated more/less occurrences of higher-level knowledge construction to examine the use of peer facilitation techniques. The peer facilitation techniques were from their previous study (Hew & Cheung, 2008). Their study revealed that, in the threads that have more higher-level knowledge construction, peer facilitators used significantly more techniques such as providing own opinions, showing appreciation, encouraging contribution, and summarizing. Similarly, Lim et al. (2011) investigated the types of techniques employed by student facilitators in online discussion that achieved more/less higher level of critical thinking. Their codes of facilitation techniques were not re-determined but emerged from the data. The identified peer facilitation techniques include: invite feedback or comments, expressing agreements, acknowledgement or showing appreciation, challenge others' viewpoints, questioning, summarize salient points, make connection, providing opinions/ explanation, and establish new threads/directions. Their results showed that, in the threads that demonstrated more higher-level critical thinking (top 30%), student facilitators frequently used social and intellectual types of techniques such as questioning, expressing agreements, providing opinions or explanations, and showing acknowledgement or appreciation. While in the threads that achieved less higher-level critical thinking (bottom 30%), facilitators merely used the social and organizational types of facilitation such as showing acknowledgement or appreciation and inviting feedback or comments.

More empirical research on peer facilitation is needed to delineate the types of facilitation techniques and the effects of the particular techniques on students' thinking and learning (Ng et al., 2010; Ng et al., 2012). In the present study, the researcher will examine how peer facilitators' use of techniques can help explain the variation in students' cognitive presence, and how these techniques created or undermined the opportunities for developing cognitive presence.

Metacognitive Practice

In a community of inquiry, providing opportunities for metacognition is one of the most important strategies to promote students' cognitive presence (Garrison, 2003). In this section, I discuss what metacognition means, and the metacognitive practices that enhance cognitive presence.

Metacognitive Awareness

Metacognition, upon which students take on their responsibilities in self-regulating their contributions in a community of inquiry, is an important component in creating cognitive presence (Garrison & Akyol, 2013). It has been found to be closely associated with students' success in cognitive activities such as attention focusing, comprehension, and problem solving (Flavell, 1979; Whitebread & Pino-Pasternak,2010).

According to Tobias and Everson (2009), metacognition is defined as "a higher-order, executive process that monitors and coordinates other cognitive processes engaged during learning" (p.108). To understand the metacognition required for creating quality cognitive presence, Garrison and Akyol (2013) decomposed this process into three factors: prior knowledge base, metacognitive awareness, and the metacognitive actions. They argued that the metacognition functions through the actions and interaction among the three.

Metacognitive awareness is the dimension this study focuses on. Compared to the other two factors, metacognitive awareness is the fundamental one that affects the effectiveness of the metacognitive actions, while at the same time, the instructor still has the chance to use intervention to facilitate. Metacognitive awareness refers to "the awareness and willingness to reflect upon the learning process", which is achieved through students' understanding and self-assessment of their progress and efforts in performing learning tasks (Garrison & Akyol, 2011, p.184). Garrison and Akyol (2013) pointed out that such awareness of metacognition is closely related to the understanding of phases of inquiry as outlined in the PI model. When students stay aware of which phase of cognitive presence they have achieved, it is more likely that they can select effective learning strategies to regulate their learning (Garrison, 2003).

Metacognitive Practice-post Labeling

Metacognitive practice refers to the strategies that aim to enhance students' metacognitive awareness of their learning and thinking process. Garrison (2003) suggested that sharing the PI model and the concept of cognitive presence with students is a promising practice that can promote the development of cognitive presence.

de Leng et al. (2009) then applied this approach in their experimental study. To prepare students' metacognitive knowledge on the PI model, they provided students with guidance that described in detail the meaning and characteristics of the four phases of cognitive presence. They also developed a checklist of guiding questions that were derived from a literature review. 3-4 guiding questions corresponded to each phase of cognitive presence to help students differentiate between the different phases. To encourage students to explicitly show their metacognitive awareness, the practice of post labeling was adopted. Before students wrote a message, they were asked to label the type of contribution they were going to make by selecting a cognitive presence

phase from a menu. The results of this study provided empirical evidence supporting the effectiveness of sharing the PI model and labeling posts in facilitating students' critical thinking in class discourse.

Post labeling, which has been recommended by a number of researchers, is a scaffolding approach in collaborative learning. In 1994, Edelson and O'Neill reported the use of post labeling in a computer-based collaborative learning environment they had developed for a high school science class. Students needed to label the webpage content they created using labels such as "information", "commentary", "question", "evidence for/against", "Plan". Later Hewitt, Scardamalia & Webb (1997) and Duffy et al. (1998) extended the use of post labeling to various group learning contexts in which students labeled their contributions in the group. The label examples include "high level question", "my theory", "new experiment", "conclusion", "synthesis", "important point", "evidence", and "expert opinion". Unlike the previous studies that used labels to highlight the contribution in terms of post content, Hoadley and Linn (2000) encouraged students to be aware of the connections between their ideas and others' contributions by providing them with semantic labels such as "and", "or", "but", "i.e." and "?".

Several attempts have been made to apply post labeling in online discussion to particularly support students' construction of argumentations. In Oh and Jonassen's (2007) study, students were required to select an argument type from a prescribed label list (e.g., problem identification, hypothesize cause, solution generation, verification, rebuttal, evidence, and elaboration). To help students see the structure of argumentation, Tsai et al. (2013) embedded the post labeling feature into the argument-oriented discussion environment *iArgue*. In their study, students were provided with instruction on the definition of argumentation and examples of good arguments, and then were asked to select a label of argumentation type, such

as “claims”, “grounds”, “warrants”, “backing”, and “rebuttals” after writing a post. Similarly, in Stegmann et al.’s (2007) study, they instructed students on constructing arguments. However, they changed the timing for post labeling. They asked students to select the type of input box (e.g., claim, grounds, qualifications, questions, comments, emotion) before composing their arguments.

In addition to the text-based argumentation environments, Schwarz & Glassner (2007), McLaren et al. (2010), Scheuer et al. (2013), and Dragon et al. (2013) developed some discussion-based argument diagramming tools that allow students to use labeled text boxes and links to visualize their argumentation. For example, in Schwarz and Glassner’s (2007) study, the labeled text boxes were different shapes that represented the different components of argumentation (e.g., opinion, fact, reason, defending, and challenging), and labeled links were different arrows that reflected the relationships between these components (e.g., support, opposition).

Schwarz and Glassne (2007) went beyond the emphasis on the components of composing arguments. They started to notice the metacognitive level of making arguments and recognized the benefits of these labels in eliciting students’ “meta-argumentative considerations”. Following this line, Valcke et al. (2009) employed the post labeling strategy to foster a higher level of metacognitive regulation in students’ online discussion. They required the students to label their posts based on Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis, evaluation). Gao (2014) combined the use of labels and metacognitive strategies to boost quality discussion. She trained the students on using five online discussion strategies: elaborating/clarifying, making connections, challenging others’ view, building upon others’

view, and questioning. Students were encouraged to employ and be aware of these strategies in the discussion, and to label their posts regarding what particular strategy they had used.

The pedagogical benefits of post labeling have been supported by several studies. These studies showed that, when post labeling was adopted, students utilized more metacognitive discussion strategies (Gao, 2014); generated more evidence, hypothesis, elaboration, and evaluation posts (Oh &Jonassen, 2007; Scheuer et al., 2013); achieved higher quality of single argumentation (Stegmann, et al., 2007); and showed a more positive attitude toward learning (Scheuer et al., 2013) and higher degree of metacognitive regulation in planning, achieving clarity and monitoring (Valcke, et al., 2009).

However, there existed mixed findings on the effectiveness of post labeling. Jeong & Joung (2007) examined the effects of labels on collaborative argumentation and reported negative effects. They experimented with three conditions: 1) Experiment group I received instruction to create specific types of posts (e.g., arguments, evidence, critique, and explanation); 2) Experiment group II received instruction to post specific types of posts, and to manually label their posts type; and 3) Control group received none of the above instruction. They found that, compared to the other two groups, the students in experiment group II who needed to label their posts were less likely to challenge others and respond to the critiques from others. They concluded that the use of labels hindered the processes of generating critical argumentation and potentially inhibited students' learning. Tsai et al.'s (2013) study conducted detailed examination of the effects of post labeling. They examined students' conceptions of and approaches to online argumentation with the highest frequency (main level) and highest hierarchical level (achieved level). The results showed that the post labeling influenced students' approach to argumentation at the achieved level. However, post labeling did not have any effect on students' approach at the

main level nor on students' conceptions at either the main or achieved level. Some researchers raised doubts regarding the use of post labeling in its potential to inhibit the spontaneity of communication and idea generation (Hollingshead, 1996; Saba & Shearer, 1994), or suppress the sharing of some ideas that cannot be easily assigned a label (Jeong & Joung, 2007). Therefore, so far, the findings on the effects of the post labeling have not lead to a firm conclusion yet. The prior research has raised many questions in need of further investigation on how post labeling can be effectively used, and what its effects are on students learning at both the cognitive and metacognitive level.

Summary

Figure 3 summarizes the topics I have reviewed in this chapter and illustrates the relationships among these topics.

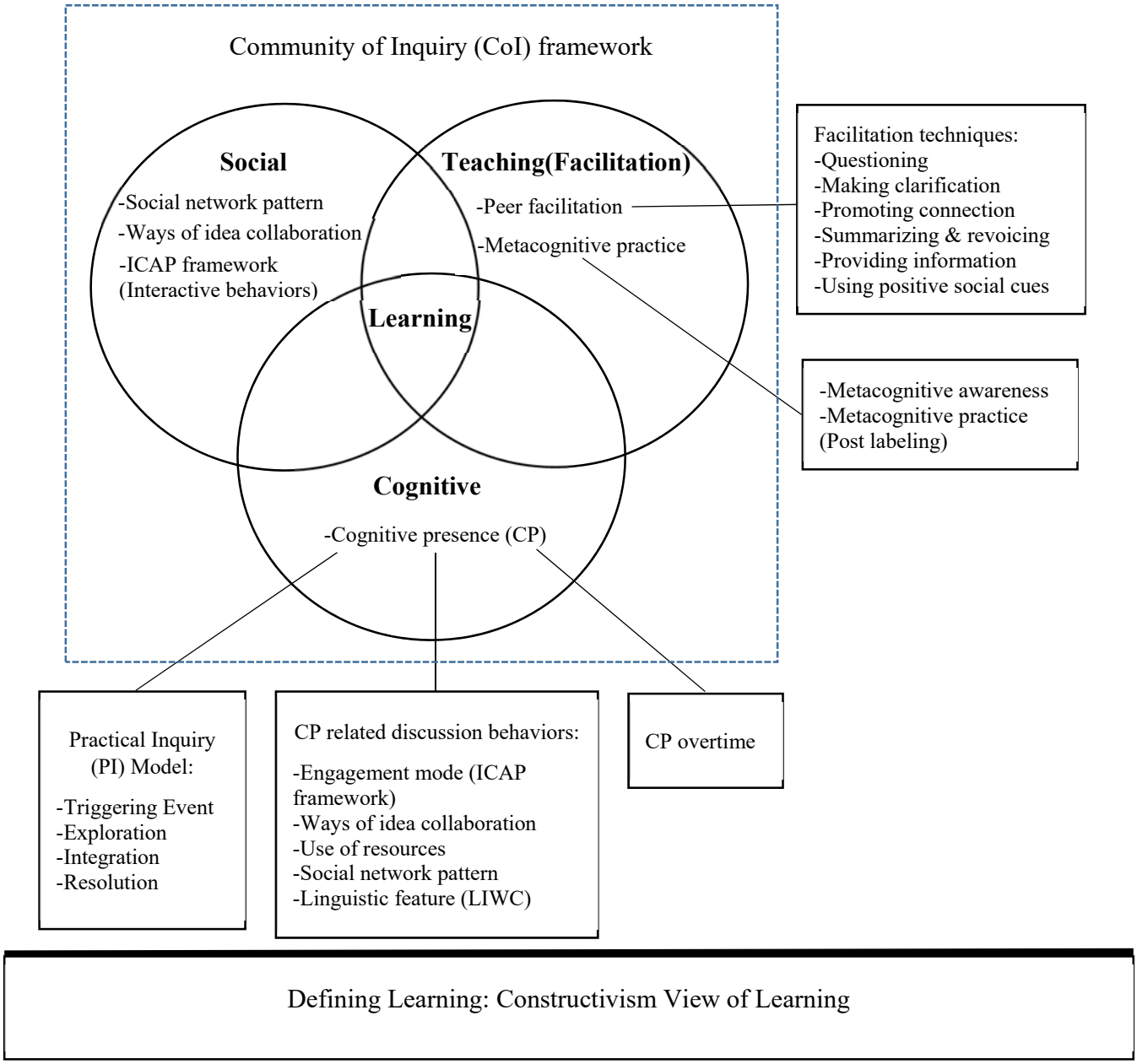


Figure 3. Summary of the content in Chapter 2

CHAPTER 3

METHODOLOGY

Chapter Overview

The goal of this study was to understand students' cognitive presence in a peer-facilitated discussion environment and to explore the practices that can enhance cognitive presence development. This study, in the context of peer-facilitated asynchronous online discussion, investigated the characteristics and patterns of students' cognitive presence, and revealed how peer facilitation techniques and the metacognitive practice could affect the cognitive presence. Experiments were conducted to determine the effects. In the experiments, peer facilitators were scaffolded by external guidance on peer facilitation techniques, and students were provided with guidance on the PI model and the post labeling of their cognitive presence.

Research Questions

In the first chapter, I discussed the gaps in research on cognitive presence and the facilitation practices. These identified gaps served as a guide for my research questions. In this study, the following research questions were proposed:

Q1: What are the characteristics and patterns of students' cognitive presence in peer-facilitated AOD?

To answer this question, I presented these sub-questions:

In the following three situations: When: 1) peer facilitators are not supported by any external guidance; 2) students are provided the guidance on metacognitive practice, and 3) peer facilitators are supported by external guidance on peer facilitation techniques,

q1.1 What types of cognitive presence are exhibited by learners? What is the distribution pattern?

q1.2 How does cognitive presence change as the discussion evolves?

q1.3 What are the characteristics and pattern of students' overt discussion behaviors (e.g., engagement mode, social network pattern, ways of idea collaboration, use of resources, linguistic feature) in different phases of cognitive presence?

Q2: Whether and how peer facilitation and the guidance of peer facilitation techniques affect students' cognitive presence? What are the effective facilitation techniques that promote cognitive presence?

q2.1 Whether and how the guidance on peer facilitation techniques affects students' cognitive presence and the related discussion behaviors in peer-facilitated AOD? How do peer facilitators select and use facilitation techniques?

q2.2 What is the relationship between students' cognitive presence and peer facilitating techniques? What are the effective techniques that led to more/later-phase cognitive presence? How do these techniques influence the cognitive presence development?

Q3: Whether or not the metacognitive practice affects students' cognitive presence in peer-facilitated AOD?

Research Context

The research setting was a 15-week graduate-level online course in the school of education at a northeastern university in the United States. The purpose of this course was to educate students on emerging educational technologies and skills in integrating technology in educational settings.

Online discussion was an important activity in this course for students to share their thoughts on weekly readings. Each week, students were provided with readings on a particular technology topic, such as asynchronous communication, mobile learning, personal broadcasting,

assistive technology, and cybersecurity. Based on the weekly readings, they were required to participate in the online discussion within a group of 15-20 members.

Peer facilitation was employed. Students took turns playing the guiding role as student facilitator. As the facilitator, they needed to ask 2-3 initiating questions, which were expected to relate with the pedagogical, technological, social, cultural, ethical, or psychological issues in integrating a particular type of technology. The below listed some examples of initiating questions,

> "With the increase of use of social media, how can we minimize the amount of cyber bullying, harassment and abuse of social media networks?";
> "What can we, as educators, do with personal broadcasting in the class room beyond recording our lessons for student use?";
> "What WEB 2.0 software do you use? Why?";
> "Is there a lack of quality in virtual universities compared to a physical classroom with the instructor and other students? How does technology help or hinder traditional learning? Is the material or course easier or harder to understand in virtual learning?".

During the discussion week, student facilitators were expected to check the forum every day, and provide support to the ongoing conversation.

Students were expected to check the discussion forum at least three times a week and to participate in all discussions that were initiated by facilitators. Each week, for each initiating question, students were asked to contribute at least one original post and one response to a classmate's post. According to the class syllabus (p.11), students were encouraged to contribute their "reflection on activities or presentations, critiques of assigned readings, and personal anecdotes of the impact of the discussion topic in an educational setting, etc". Students were also required to limit their post to one or two paragraphs. For example,

> **Student facilitator**: With the increase of use of social media, how can we minimize the amount of cyber bullying, harassment and abuse of social media networks?
> **Student 1**: In my experience with 7th graders (and my knowledge of the issue on a national level from the media), I believe that the only way to combat cyber bullying & harassment is to aggressively address it, while recognizing that the emotions being

> articulated are not new, it's just that the format has now been opened up. In other words, kids/teens have always gossiped and talked about one another, it's just always been done through tiny notes folded up and stuck through locker slats or through whispers in the cafeteria. The explosion of cyber bullying and harassment is merely an outgrowth of the medium, not a fundamental change in humanity, as some would have us believe. That said, I think that we, as a nation, are talking about the detrimental affects of hurtful language and harassment, which, in many respects, is making it easier to combat and giving validity to victims who have not historically had a voice. The response to victimization must be swift, public and appropriate, addressing the underlying issues of ignorance, power and fear. Silencing teenagers online will only force them to revert to less public forms of harassment, where both victim and perpetrator are invisible to adults, in general.

At the beginning of the semester, the instructor let students choose the week/topic in which they would like to facilitate. According to students' preferences, the instructor assigned them the discussion week/topic. Syllabus provided instruction on the specific role and responsibility of a student facilitator. Before each week, the instructor sent a reminder email to student facilitators about their duties. Once facilitators posted their question in the forum, the instructor immediately posted an announcement on the course site to invite students to participate in the discussion. During the discussion week, the instructor monitored the discussion and provided support when it was needed. How the discussion started and evolved depended on the students themselves.

The discussion participation accounted for 30% of the final grades. Particularly, 20% was for their regular weekly participation and 10% was for their facilitation work in the assigned week. For the weekly participation, students were given credits for the number of the posts they contributed to the forum.

Design & Procedures

To answer the research questions, an experiment was conducted in a naturalistic online class. Two cohorts of students (2014 Fall and 2015 Fall) from the same course were involved.

The 2014 Fall class served as the control group, and the 2015 Fall class served as the experiment group. The same instructor taught both classes.

This study featured a two-phase experimental intervention. Starting from the second week of the course, the guidance of using peer facilitation techniques was provided to student facilitators. From the eighth to the fourteenth week, in addition to the guidance of peer facilitation techniques, all the students were provided with the guidance of labeling of their cognitive presence.

The interventions are summarized in Table 2.

Table 2: Intervention design

	Phase 1	Phase 2
Intervention	-Guidance on facilitating strategies was given to student facilitators	- Guidance on facilitating techniques was given to student facilitators - Guidance on PI model and the post labeling is given to students
Time periods	Week 2-Week 7	Week 8-Week 14

Guidance on peer facilitation techniques. 3-4 days before the discussion started, the TA sent the instruction manual on peer facilitation techniques to the student facilitator(s) via email. The manual introduced six types of techniques including asking a question, making a clarification, promoting connection, summarizing & revoicing, providing information, and using positive social cues. These techniques were developed by analyzing the discussion transcripts from online classes in the researcher's previous study and were also validated by literature discussed in Chapter 2.

Specifically, the manual explained what each technique was, how it could be used, and the concrete examples from previous students' posts (see Appendix A). The TA also sent them a checklist of facilitation techniques. The techniques are summarized in Table 3. The facilitators

were asked to record their technique use using this checklist, including whether or not they used a facilitation technique, and what other strategies they found useful but not listed in the manual. Once the discussion was over, they were required to send this checklist back to the TA.

Table 3: Peer facilitation techniques

Strategies	
Ask a question	• Ask explanatory question • Ask factual questions • Check joint understanding
Make a clarification	• Give logical or theoretical explanations • Give examples from real life • Create analogies
Promote connections	• Cue students' prior knowledge or personal experience • Cue reading materials • Cue class projects • Cue previous discussion messages
Synthesis & revoice	• Synthesize available ideas • Revoicing-highlight the important idea(s) • Reflect on the discussion progress
Provide information	• Introducing facts from experience • Introducing facts from authoritative sources • Present alternate perspectives • Identify problems
Use positive social cues	• Show agreement/empathy/shared understanding • Praise • Show thanks • Invite open discussion

In addition to the manual, support was provided to student facilitators to help them better understand the manual. For example, 1) the TA monitored student facilitators' performance in facilitation, and would contact facilitators for further communication if they failed to facilitate or misused the peer facilitation techniques; 2) One focus of the manual was to help student facilitators to ask quality initiating questions. Before posting questions to the forum, student facilitators were asked to send the questions to the TA. The TA reviewed facilitators' questions to see whether the questions were ready to post or how they could be improved; 3) Through posting Blackboard announcement, sending emails, including contact information in the

instruction manual, the TA reached out to student facilitators and encouraged them to contact TA when they need any assistance.

Guidance on metacognitive practice – post labeling. At the beginning of the eighth week, an instruction manual for the metacognitive practice was posted on the course site. The manual explained the concept of cognitive presence and the four phases of developing cognitive presence (PI model). Examples from previous students were also provided to delineate each type of cognitive presence.

Students were asked to think about what cognitive presence categories their post could fall in after they had written a post. Then, as shown in Figure 4, they needed to manually type in the category in the post title box to specify which cognitive presence phase(s) they had demonstrated in their writing. There were four tag options they could choose from: Triggering event, Exploration, Integration, and Resolution. If they considered their post involved multiple categories, they were asked to type all the possible categories. If they considered their post did not belong to any of the four categories, they were asked label the post as 'others'.

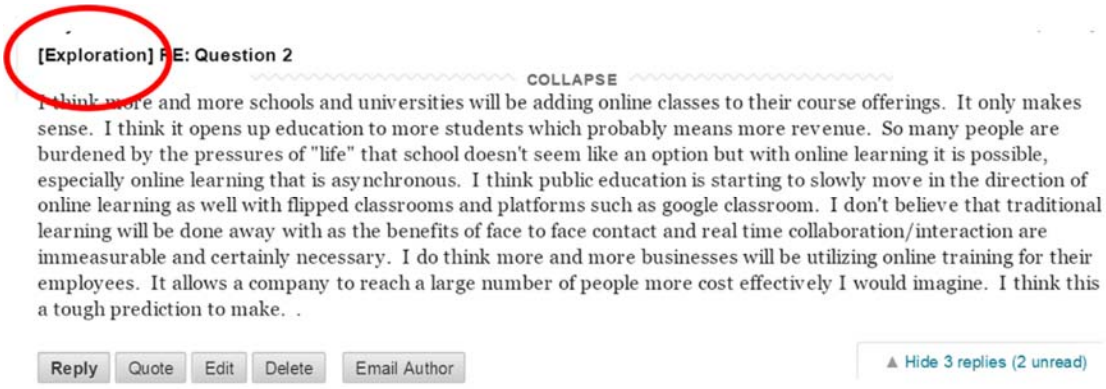


Figure 4. Labeling of posts in terms of cognitive presence phase (s)

The TA closely monitored students' labeling to make sure every post was labeled. Reminder email(s) would be sent to the students who forgot to label their posts until they finished the labeling.

There were six weeks for phase 1 intervention and seven weeks for phase 2. One more week was added in the second phase, as students perhaps needed some time to learn the rules of the metacognitive practice and form the habit of labeling their posts. The discussion in the first week of phase 2 might not reflect the effect of the added intervention.

Participants

A total of 53 students who enrolled in this course participated in this study. They were graduate students primarily from education-related majors with a noticeable diversity in their undergraduate education background, such as business, linguistics, communications, information studies, sociology, psychology, public health, engineering, poetry, literature, and sport management. Among these participants, 46.3% were male, and 53.7% were female. The majority of students in this study were domestic students (79.6%), and the rest (20.4%) were international students. All the students in this course had some teaching experience. About 31.5% of the students were in-service teachers or coaches in the contexts of K-12 school, college, or industry, and the rest reported that they had some experience as a tutor or teaching assistant. Students' demographic information in the two sections is summarized in Table 4.

Table 4: Students' demographic information

Group		# of students	Gender (male/female)	# of teachers/coaches in K-12, college, or company	# of athlete
Control Group (Fall 2014)		17	10/7	6	8
Treatment Group (Fall 2015)	Blue	17	12/5	7	7
	Orange	19	3/16	4	10

As shown in Table 4, the students who enrolled in 2015 Fall were about twice as many as the students in 2014 Fall. To minimize the possible effect of group size on students' discussion performance, the students in 2015 Fall were divided into two groups. Based on the researcher's knowledge about this course, there were two types of students who might influence the interpretation of the effects of the intervention. The first type were those students who had more

in-service teaching experience and were more likely to have more expertise in facilitating a discussion, as well as more knowledge about teaching. The second type were the student athletes who usually needed more support during the course since they faced more challenges in balancing academics and sports.

Stratified sampling was used in forming the two groups. The researcher divided the treatment group population into three subgroups: in-service teachers; student athletes; other students. Then, from each group, the researcher randomly selected subjects and evenly assigned them into the two groups, Orange group and Blue group, to make sure that the relevant backgrounds of students in the two groups were parallel to each other. Finally, there were 19 students in the Orange group, and 17 students in the Blue group (3 students dropped the course during the semester).

The difference between the treatment and the control group was purposefully controlled. The two groups were from the same course and were taught by the same instructor. Except the interventions, the two groups had the same learning topics, materials, class assignments, and grading rubrics. As shown in Table 4, the size of discussion subgroups, the number of in-service teachers, and the number of student athletes were similar between the treatment and the control group.

Data Collection & Instruments

Data were collected across 2014 Fall and 2015 Fall through multiple sources: forum discussion, student survey, student artifacts, class materials, and the researcher's observations.

Forum Discussion Transcripts

As the discussion forum was the important platform where the class discourse occurred, the discussion transcripts generated by students in the forum were the primary data source. The

collected transcripts included information such as the content students wrote in the posts, the date and time of submitting the posts, and the author of the posts (each participant was given a pseudonym to ensure anonymity).

In the course, the discussion activity lasted for 14 weeks. However, the discussion of the first week was a warm-up activity, and the discussion content was not relevant to the learning content. The purpose of the first week's discussion was to let students introduce themselves to the class, and get them familiarized with forum use (post/reply a message). Thus, the posts in the first week were excluded from the data set. The posts from second week to the last week were collected. Repeatedly posted messages and messages containing no content were deleted, yielding a total of 2557 posts. Among them, 530 posts were from 2014 Fall, and 2027 from 2015 Fall (920 and 1107 posts were respectively produced by the two groups in 2015 Fall class).

Student Survey

Data were also collected through survey to understand students' perceptions and thoughts on their cognitive presence, peer facilitation, social interaction, and the two interventions.

The survey was adapted from the CoI instrument developed by Arbaugh et al. (2008a). The original instrument was a 34-item survey that purports to measure social, teaching, and cognitive presence in an online learning environment. A number of previous studies have tested the reliability and validity of this instrument (e.g., Arbaugh, et al., 2008b; Kozan, et al., 2014). For the purpose of this study, those items that measured cognitive presence and social presence, and the nine items in teaching presence that measured the peer facilitation aspects, were kept while those items intended for direct instruction and course design were excluded. Nine original items were revised by replacing the word "instructor" with "student facilitator". For example,

"The instructor provided feedback in a timely fashion" was changed to "The student facilitators provided feedback in a timely fashion".

The survey included the following sections: 1) background information of students, such as years of teaching experience, and/or tutoring experience; 2) self-assessment of their cognitive presence; 3) perception of peer facilitation; 4) perception of social interaction; and 5) perception of the peer facilitation techniques and the metacognitive practice. The questions in section 2-5 were measured on Likert scale with a scale of 1-5 (1=Strongly Disagree, 5=Strongly Agree).

The survey was created using Qualtrics, an online survey system. In 2015 Fall, the link to the survey was sent to students through email during the final week of the course. Announcement of the survey was also posted on the course management system. Students who completed the survey received bonus course credits. A total of 28 responses were gathered from the 36 students, resulting in a response rate of 77.8%.

Student Artifacts, Class materials, & Researcher's observations

Additional data were gathered to help understand the context of students' behaviors and activities in discussion, and triangulate the findings obtained from the discussion transcripts and student survey. The data were collected by means of: 1) student artifacts. For example, the emails between students and TAs and facilitators' checklist that recorded their technique use were analyzed to reveal student facilitators' perception of peer facilitation and online discussion. In addition, students' manual labels of posts were also collected to help the researcher to assess whether the students correctly understood the meaning of four phases of cognitive presence; 2) class materials, such as the syllabus, class announcements, and weekly readings were used to collect information about the contect of this course and the online discussions; and 3)

researcher's in-class observations. The researcher observed the class in 2015 Fall, and used Excel documents to record students' participation and interaction in online discussion.

Data Analysis

A number of qualitative and quantitative data analysis methods were used to examine the characteristics and patterns of cognitive presence, and the effects of providing guidance on peer facilitation techniques and asking students to label their cognitive presence. The researcher employed qualitative content analysis, automated linguistic analysis, and social network analysis to identify cognitive presence, peer facilitating techniques, discussion behaviors, and the social networks emerged from online discussion. Conversation analysis was performed to analyze the dynamic process of cognitive presence evolvement and how specific facilitation techniques shaped the discussion. Bayesian approach, a quantitative statistical analysis method, was conducted to reveal the patterns of cognitive presence distribution and evolvement, the effects of providing guidance on peer facilitation and asking students to label their cognitive presence, what the effective peer facilitation techniques were, and the relationships between and among cognitive presence, peer facilitation techniques, and students' discussion behaviors.

Content Analysis

The selection of data analysis methods depended on the research questions being asked. Since the goal of this study was to investigate in AOD *what* types of cognitive presence students demonstrated, *how* students created cognitive presence, *how* peer facilitation shaped the discussion, and *why* certain types of peer facilitation techniques were able to facilitate students' cognitive presence development, it was important to examine the content of the students' utterances in the discussion rather than the surface quantifiable aspects such as length of posts or number of words. Qualitative content analysis provides an appropriate way to answer the above

questions that focus on "what happens in a given context, how the events take place and why they occur" (Schrire, 2006, p.52). Content analysis has also been a commonly used method to analyze the cognitive activities in communication transcripts (e.g., Akyol, et al., 2011; Koehler, et al., 2007; Vaughan, et al., 2005). Therefore, in this study, the data from discussion transcripts were submitted to content analysis.

Choosing coding schemes. Selecting a coding scheme depends on the dimensions the study examines. To understand the complexity of cognitive presence and peer facilitation in AOD, it is important to consider different dimensions of students' behaviors in the studied situation and use multiple taxonomies in operationalizing cognitive constructs (Schrire, 2006).

The CoI framework guided the choosing of the dimensions that were worth attention. Cognitive presence is inextricably linked with teaching and social aspects of online learning (Garrison & Anderson, 2003), as supported by Mercer et al. (1999). They pointed out that class discourse has three aspects that are inseparable: the cognitive dimension that processes knowledge, the social dimension that shares knowledge, and the pedagogical dimension that provides "intellectual guidance" to peers. Therefore, cognitive presence cannot be examined in isolation but should be studied in the context of the other two. In this study, coding schemes were chosen to measure cognitive presence (cognitive), peer facilitation techniques (teaching), and students' discussion behaviors (cognitive & social).

The following coding schemes were used in this study:

1) Cognitive presence. The PI model was used to measure the construct of cognitive presence as it defines and operationalizes the four phases of cognitive presence development: Triggering Event, Exploration, Integration, and Resolution. The coding scheme is illustrated in Table 5.

Table 5: Coding scheme for cognitive presence (Garrison & Anderson, 2003)

Phase	Indicator	Description
Triggering Event	Recognize problem	Presenting background information that culminates in a question
	Puzzlement	Asking questions; Messages that take discussion in new direction
Exploration	Divergence	Unsubstantiated contradiction of previous ideas; Many different ideas/themes presented in one message
	Information exchange	Personal narratives, descriptions, facts (not used as evidence to support a conclusion)
	Suggestions	Author explicitly characterizes message as exploration—e.g., "Does that seem about right?"
	Brainstorming	Adds to established points but does not systematically defend/justify/develop addition
	Intuitive leaps	Offers unsupported opinions
Integration	Convergence	Reference to previous message followed by substantiated agreement, e.g., "I agree because..."; Building on, adding to others' ideas Justified; Justified, developed, defensible, yet tentative hypotheses
	Synthesis	Integrating information from various sources-textbook, articles, personal experience
	Solution	Explicit characterization of message as a solution by participant
Resolution	Apply Test Defend	

2) Peer facilitation techniques. Table 2 served as the coding scheme for coding the peer facilitation techniques. These techniques were identified from the discussion transcripts in previous classes. They were validated by finding empirical evidence from literature (see Chapter 2). For the purpose of not letting the pre-established codes restrict the coding, new codes of facilitation techniques were allowed to emerge from data.

3) Engagement mode. ICAP framework has defined the observable overt activities in classrooms that reflect students' cognitive engagement (Chi, 2014). The codes in this framework are different from the ones in PI model: PI identifies the phases of cognitive presence development, but ICAP articulates the cognitively relevant behaviors that can occur in any phase

of cognitive presence. There were two reasons for choosing ICAP as a coding scheme. Firstly, these codes were expected to help reveal *what students did* and the sophistication of their engagement and interaction in creating and developing cognitive presence. Secondly, although PI model included students' cognitive activities in both shared world (discourse) and individual world (reflection), the four codes did not differentiate between the two. The ICAP framework tackled this issue by explicitly identifying the cognitive behaviors that arise out of the social interaction in the shared world. This study, from the constructivism perspective, emphasized the socially constructive process of creating cognitive presence, and the ICAP framework can help achieve this goal. Wang and her colleagues (2016) extended Chi's work by adapting this framework to online discussion settings. They developed a coding manual[2] to capture the cognitively relevant discussion behaviors (codes as shown in Table 6). In this study, this manual guided the coding of students' discussion behaviors that reflected their cognitive engagement.

Table 6: ICAP framework (Adapted from Wang, et al., 2016)

Discussion behavior	Definition
Interactive_Higher	For a post to be interactive_higher, it should be 1) constructive_higher 2) targeting at a specific counterpart. This includes elaborating on, pointing to, building upon and challenging their partner's ideas.
Interactive_Lower	For a post to be interactive_lower, it should be 1) constructive_lower 2) targeting at a specific counterpart.
Constructive_Higher-Elaboration and Reasoning	If the user displays reasoning in the post by elaborating on a point, explaining a phenomenon, making a cause and effect relationship or comparing two conditions
Constructive_lower - propose an idea	If the post doesn't contain any explanation or reasoning, but it proposes a new idea, asks a question or contains content that is related to the course but go beyond what's covered in the course materials, for example referring to relative external resources
Active_higher-Paraphrase, repeat,	If the user is displaying engagement with course materials in the post by paraphrasing, repeating, or mapping resources, which shows the

[2] The coding manual can be retrieved from: http://dance.cs.cmu.edu/MOOC-ICAP-Manual.pdf

and resources mapping	student is actively engaged in course materials, and referring to specific content of course materials
Active_lower-Imply attention to or engagement with course materials	If the student shows evidence that he/she is being engaged with course materials, including watching videos, reading textbooks, taking notes, etc., without mentioning what the content is

4) Ways of idea collaboration. This study investigated, in the shared world, how students collectively develop cognitive presence. To characterize students' contributions in the interacting and collaborating, the codes in Table 7 were used to capture the ways of idea collaboration.

Table 7: Idea collaboration (Hmelo-Silver & Barrows, 2008)

Discussion behavior	Definition
New idea	Mentioned idea not previously introduced
Modification: change an idea previously mentioned	Changing an idea previously mentioned—may include elaboration, clarification, revision
Agreement	Indication of shared opinion or understanding
Disagreement	Indication of difference of opinion or understanding
Meta	Indication of monitoring collective or individual understanding (e.g., "I think this makes sense"), task-related progress (e.g., we need to write a new problem definition), and self-directed learning (e.g., "I think that should be a learning issue").

5) Constructive use of information. In addition to creating innovative ideas, the discussion dynamics of developing cognitive presence also involve students' constructive use of external recourses to build knowledge and understanding (Zhang, et al., 2007). Besides, in the AOD environment, students have time to search for more information to improve their ideas. The use of the resources can reflect their efforts in creating connection between the discussed topic and other recourses they have found. The codes listed in Table 8 were used for capturing these discussion behaviors.

Table 8: Ways of using information (Zhang, et al., 2007)

Discussion behavior	Definition
Empirical data-Experiments	Report results of self-identified experiments

Empirical data-Observations or past experience	Report relevant phenomena, recall life experience
Expert resource- Introduce new information	Rephrase or summarize information from readings, the internet, experts, or teachers, etc.
Expert resource-Go beyond given information	Use expert resources to aid/advance personal ideas and understandings

Determining unit of analysis. Unit of analysis was identified to unitize the transcripts before coding starts. Unitizing can make practical the check of inter-rater reliability and the calculation of the frequency of code occurrence. The units frequently mentioned in literature are a message, a paragraph, a unit of meaning, a sentence, an illocutionary act, a conversation turn, or an episode of an event/activity. In this study, transcripts were segmented into units of meaning. A unit of meaning refers to an independent idea, theme, or argument chain (Chi, 1997; Henri, 1992; Strijbos, et al., 2006; Veldhuis-Diermanse, 2002). The course in this study was at the graduate level. The AOD messages produced by the students at this level tended to be long, complex, and contain different topics that made the whole message apply to multiple coding categories (Strijbos, et al., 2006). According to Hew and Cheung (2011, p.309), data analysis at the level of idea/theme can not only help break down the complexity of analysis, but also help stay "heuristic and able to stand by itself". Also, this study emphasized students' cognitively related activities. To determine the segment boundaries when analyzing these activities, reading the transcripts for meaning is more meaningful and appropriate than using other grain sizes (Merriam, 2001).

Coding. Once the analysis of unit was determined, the next step was to assign code(s) to each unit. The segmentation and coding was performed simultaneously as recommended by previous studies (e.g,. Hara et al., 2000; Henri, 1992). Each message was read at least twice: the first round divided the message into meaning units, and the second round searched the evidence in the content that corresponded to the description of the codes. The evidence included the overt

behaviors or act (e.g., ask a question), connecting words (e.g., because), indicator sentences (e.g., agreement—"I Agree…", expert resource—"the article pointed out…"), or researcher's interpretation of the reasoning or argument. For the codes of cognitive phases/activities (the PI model or the ICAP framework), each unit was coded for the category that was most obvious. Given the complexity of the discussion dynamics and the relevant cognitive process, it was unsurprising that a single meaning unit involved multiple codes (Garrison, et al., 2000). Thus, in the coding, a unit could be assigned multiple codes that were from the same coding scheme.

In interpreting the meaning of a single unit, the local level of the unit being coded was analyzed. If there was any ambiguity in interpreting, the content before or after the current unit was examined to get a broader context and to maximize researchers' comprehension (Chi, 1997). Additionally, Glaser's constant comparative method (1965) was used, and the transcripts were coded and tested in a "forward-and-backward" way. When assigning a unit to a category, this unit was compared with the previous units coded in the same category. When some aspects in the unit could not be explained by the existing code(s) but were closely associated with the studied construct, the code(s) were refined or new codes were added.

Checking inter-rater reliability. As the segmentation and the coding created subjective bias, reliability of segmentation and coding was computed. Two outside coders were invited to code the transcripts. One coder was from the education major, and the other was a non-education major. The decision on how much content to be tested was based on the suggestion of using 5%-7% of the total transcripts (Kaid & Wadsworth,1989). In this study, 200 messages (6%) were selected at random for the inter-rater reliability check. Training was provided to the two outside coders. After the training, the researcher and the coders independently coded the selected transcripts. Discrepancies were resolved through discussion. If the consensus was not achieved,

the units were labeled as ‘’uncodable’’. The results of the coding and segmentation were compared using Cohen Kappa and are presented in Table 9. For Cohen Kappa, the threshold of the reliability used in this study was the standard suggested by Capozzoli, McSweeney, and Sinha (1999, p.6): "…values greater than 0.75 or so may be taken to represent excellent agreement beyond chance, values below 0.40 or so may be taken to represent poor agreement beyond chance, and values between 0.40 and 0.75 may be taken to represent fair to good agreement beyond chance."

Table 9: The inter-rater consistency of coding schemes

Coding scheme	Inter-rater consistency (Rater A)	Inter-rater consistency (Rater B)
Four phases of Cognitive presence	0.86	0.81
Engagement mode	0.64	0.60
Constructive use of resource	0.79	0.75
Ways of idea collaboration	0.76	0.80
Six types of peer facilitation	0.87	0.79
The specific peer facilitation techniques	0.60	0.57

Quantitative Analysis

Quantitative analysis was conducted next to seek the patterns hidden in the results of the content analysis—the frequency distribution, any reliable difference, or the relationships between and among the studied constructs. Besides, the quantitative data collected from the student survey were also analyzed.

Bayesian approach of analysis. The traditional approach of conducting quantitative analysis is Null Hypothesis Significance Testing (NHST), which tests a hypothesis and declares a statistic significance by referring to a p-value. In this study, there were some issues in analyzing the discussion data with the NHST approach. First, multiple conditions were compared in this study, and this brought in correction challenges in the determining of the p-value criteria (Kruschke, 2010). On the other hand, the data in this study violated some assumptions of NHST.

For example: 1) unbalanced sample size between the treatment and the control group; 2) a discussion thread was not a list of independent messages or units of meaning. Messages/meaning units influenced and responded to one another. 3) The cognition and discussion process was complex, and the discussion data might not be normally distributed. 4) There was a small sample size of student participants (especially in the survey). To address these issues, this study employed Bayesian approach, which does not impose the computational constraints and assumptions to data.

Bayesian analysis is a mathematical approach that reallocates the credibility of parameter values given to the actual observed data (Kruschke, et al., 2012). Compared to NHST, which generates a single point value for each parameter, Bayesian analysis provides rich and complete information about the parameters by giving probability distributions of all possible values (Kruschke, 2010). Representing the results by probability distribution fits well with the reality of the world, which is changing, variable, and uncertain (Gelman, et al., 2014).

The resulting distribution is the posterior distribution of the probability of each parameter value that is computed through Bayesian rule. To compute the posterior distribution, the Bayesian approach considers both the observed data and people's prior belief. The joint probability, the probability of two events occurring at the same time, is written as the product of prior distribution of parameter θ- p(θ) and data distribution-p(y|θ) as in (3.1).

$$p(\theta,y) = p(\theta)p(y|\theta)^{3} \quad (3.1)$$

Then, the posterior probability is calculated through (3.2):

$$P(\theta|y) = p(\theta,y)/p(y) = p(\theta)p(y|\theta)/\, p(y) = p(\theta)p(y|\theta)/\, \sum_{\theta} p(\theta)p(y|\theta) \quad (3.2)$$

[3] p(y|θ) is the probability of data conditional on the prior belief on parameter θ. Similarly, P(θ|y) is the probability of θ conditional on the observed value of data y.

Kruschke et al. (2012, p.733) pointed out that, Bayesian analysis is "exceptionally well suited for more complex applications." Unlike NHST, which holds strict assumptions on data, Bayesian approach can adapt the model to complex data distribution or structure, especially when data is nonnormal, skewed, has outliers, or data has a large number of variables or many hierarchical layers. Besides, in Bayesian analysis, the inference decisions are made without referencing p values. When multiple comparisons are made, there is "no influence from which comparison, and how many" (Kruschke, et al., 2012, p.744). Therefore, no corrections are needed in interpreting the posterior distribution. Last but not least, Bayesian approach can handle the situations of small sample size, or unbalanced sample size across different conditions/groups (Kruschke, 2015).

In Bayesian analysis, there are two ways to determine the significance of evidence: 1) Look at the posterior distribution of the parameter values. Take mean difference (MD) for example; if 95% highest density interval (HDI), where the bulk of the most credible values falls, does not include zero, or falls above zero, we can conclude that the groups' means are credibly different. 2) Look at the Bayes Factors (BF) that compare the marginal likelihoods between a null and an alternative hypothesis. Table 10 presents commonly used thresholds of BF to define significance of evidence.

Table 10: Commonly used thresholds to define significance of evidence

BF	Evidence category	BF	Evidence category	BF	Evidence category
>100	Extreme evidence for H0	1-3	Anecdotal Evidence for H0	1/30-1/10	Strong Evidence for H1
30-100	Very strong evidence for H0	1	No Evidence	1/100-1/30	Very Strong Evidence for H1
10-30	Strong evidence for H0	1/3-1	Anecdotal Evidence for H1	1/100	Extreme Evidence for H1
3-10	Moderate evidence for H0	1/10-1/3	Moderate Evidence for H1		

Analysis techniques. Descriptive statistics, such as frequency count, percentage, mean, and SD were used to describe the distribution of cognitive presence, discussion behaviors, facilitation technique use, students' perception of their discussion experience, and the evolvement pattern of cognitive presence over time.

Explanatory statistics were used to reveal the effects of the interventions on cognitive presence, and the relationships between and among cognitive presence, discussion behaviors, and the peer facilitation techniques. Particularly, 1) ANOVA tests were conducted to compare cognitive presence across different time-periods or variables (e.g., facilitating techniques, discussion behaviors), and pair-wise comparison to determine the effects of the interventions. 2) Correlation analysis was conducted to investigate the relationships between and among cognitive presence, the facilitating techniques, and discussion behaviors.

In determining the effects of the interventions, several comparisons were made, as illustrated in Table 11.

Table 11: Summary of the comparisons that were made

Purpose of comparison	Comparison Groups	
To examine the effects of pure practice	-Control group: week2-week 7	-Control group: Week8-week 14
To examine the effects of guidance on peer facilitating techniques	-Experiment group week2-week 14	-Control group: week2-week 14
	-Experiment group Week 2-Week 7	-Control group: Week 2-Week 7
To examine the effects of guidance on students' metacognitive awareness on cognitive presence	-Experiment group Week 2-Week 7	-Experiment group Week 8-Week 14
	-Experiment group Week 8-Week 14	-Control group: Week 8-Week 14

Conversation Analysis

The discussion process is dynamic: the events in this process are emerging, fluid, and changing. It deserves the exploration at a micro level: tracking the discussion over time to

understand how students created cognitive presence, how peer facilitation shaped the cognitive presence development, and why certain outcomes resulted.

In this study, based on content analysis, conversation analysis was conducted to investigate how students' discussion was moving forward. At this stage, discussion transcripts were purposively sampled to find the segmentations "from which the most can be learned" (Merriam, 2001; Schrire, 2006, p.56). Particularly, two types of segmentations of the transcripts were identified: 1) the threads that involved the most and least active cognitive presence and peer facilitation. A thread included all the discussion posts under an initiating question posed by a facilitator. 2) Episodes of conversation within a thread; an episode meant multiple posts, under a thread, that constituted a continuing conversation between/among two or more students. The conversation analysis zoomed in the threads and episodes to track the temporal development of students' cognitive presence and peer facilitators' technique use.

Linguistic Analysis

In analyzing what characterizes students' cognitive presence, the content analysis and the conversation analysis focused on the *process* of the students' discussion viewed through students' *behaviors* that were not directly content related. They studied how students talked but ignored the discussion *content* aspect that reflected what they were talking about. The epistemic content of discussion is also an important and sensitive index of to what degree students are processing a cognitive event (Carroll, 2007). In this study, linguistic analysis techniques were employed to examine the psychologically meaningful linguistic features in students' post writing.

Linguistic analysis of word use. The automated text analysis tool *Linguistic Inquiry and Word Count* (LIWC) was used to analyze the word use that indicated the psychological state of

the discussion. The use of words and language can provide important information about people's "thought process, emotional state, intentions and motivations" (Tausczik & Pennebaker, 2010, p.37). LIWC searches for the "psychology-relevant" words in text and calculates the percentages of the sets of words that have been defined by 80 psychologically important categories. To investigate the characteristics of cognitive presence in different study conditions, several relevant categories were selected, as illustrated in Table 12.

Table 12: LIWC output variables used in this study

Variables	Definitions/examples	Variables	Definitions/examples
Linguistic Dimensions		Psychological Processes	
Word count	Number of words in text	Affective processes	Number of words that presents emotions in a message, e.g. happy, cried, abandon
Words/sentence	Number of words per sentence	Positive emotion	Love, nice, sweet
Words>6 letters	Number of words longer than six letters	Negative emotion	Hurt, ugly, nasty
Comparisons	compare words, e.g. greater, best, after	Cognitive processes	Number of words that presents all cognitive processes in a message, e.g. cause, know, ought
Interrogatives	how, when, what	Insight	think, know, consider
Past tense	Past focus	Causation	because, effect, hence
Present tense	Present focus	Discrepancy	should, would, could
Future tense	Future focus	Tentative	maybe, perhaps, guess
Conjunctions	and, but, whereas	Certainty	always, never
Negations	no, not, never	Differentiation	hasn't, but, else
Quantifiers	few, many, much	Perceptual processes	Number of words that presents perceptions in a message, e.g. Observing, heard, feeling
Numbers	second, thousand	See	View, saw, seen
Prepositions	to, with, above	Hear	Listen, hearing
Question marks		Feel	Feels, touch
Exclamation marks			
Quotation marks			

Based on the results of the LWIC analysis, pairwise comparisons were made to explore whether/how the linguistic features of students' posts were related with different phases of cognitive presence.

Social Network Analysis

As discussed before, in discussion, cognitive presence arises out of, and contributes to, the social interaction among participants. To understand students' cognitive presence from the lens of social interaction, this study explored students' social network pattern using Social Network Analysis (SNA).

SNA, based on the mathematical graph theory, provides a visual representation of how individuals are connected and what the individuals' positions are within in a network (Heo, et al., 2010). In visualizing the network, each individual is represented as a node, and each interaction that occurs between two individuals is a linking line. SNA quantifies the interaction patterns using measures such as density, centrality, connectivity, betweenness and degrees (Wasserman & Faust, 1997).

This study applied SNA to students' discussion data to examine what were the patterns of students' social network in different study conditions.

Summary

To end this chapter, Figure 5 and Figure 6 summarize the present study and the procedure for data analysis. Table 13 illustrates the methods for analyzing cognitive presence and the effects of the interventions.

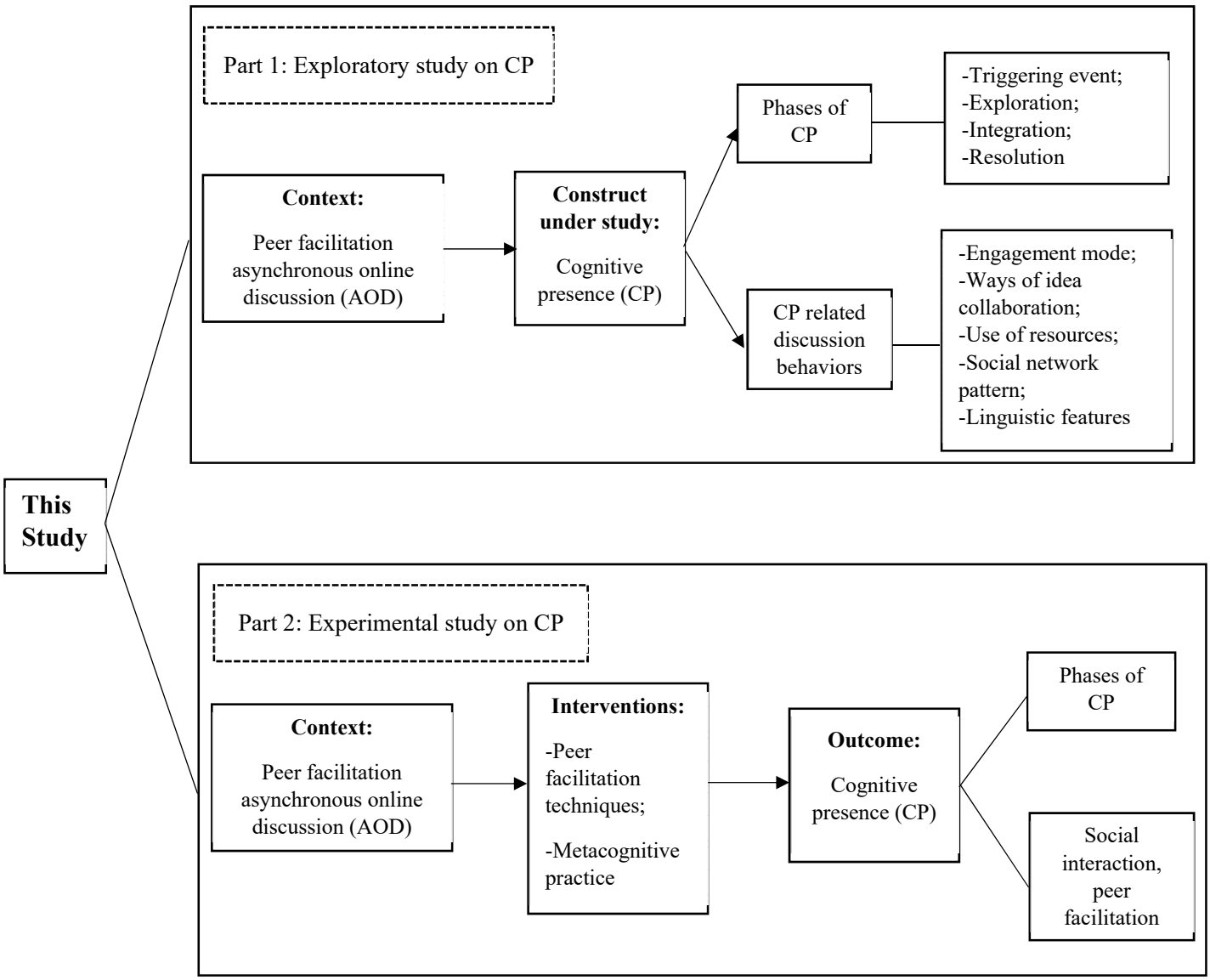


Figure 5. Summary of the present study

Table 13: Overview of data analysis

Aspects	Questions	Data source	Analysis
Characteristics of cognitive presence	Distribution pattern of cognitive presence	Discussion transcripts	Content analysis; Descriptive statistics;
	Cognitive presence evolvement overtime		Conversation analysis
	Patterns of students' discussion behaviors across CP phases (engagement mode, ways of idea collaboration, use of resources)		Content analysis; Descriptive statistics; Pairwise comparison
	Relationship between phases of cognitive presence and students' discussion behaviors (use of psychologically meaningful words)		LIWC analysis; Descriptive statistics.
	Relationship between and among cognitive presence, peer facilitation, and social interaction	Survey; Discussion transcripts.	Correlation analysis; Conversation analysis; Social network analysis
Effects of guidance on peer facilitating techniques; Effects of guidance on metacognitive awareness practice	On cognitive presence distribution	Discussion transcripts; Survey; Student artifacts; Filed notes; Class materials.	Content analysis; ANOVA.
	On cognitive presence evolvement		Conversation analysis
	The effective peer facilitation techniques that enhance cognitive presence		Correlation analysis; Conversation analysis
	On cognitive-presence relevant discussion behaviors		Correlation analysis; Social network analysis; Conversation analysis

(Note: All the statistic analysis above used Bayesian approach)

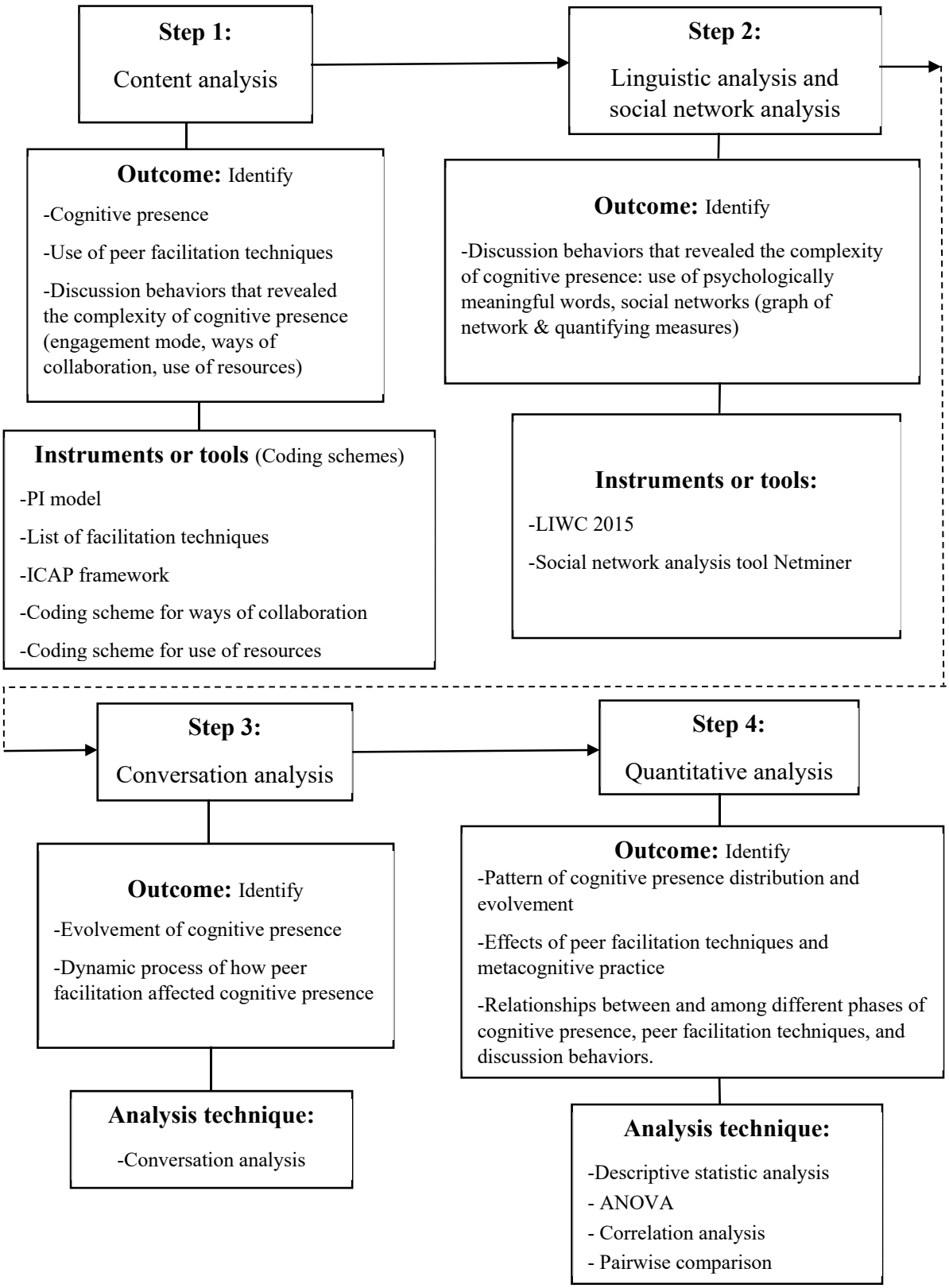


Figure 6. Summary of the analysis procedure

CHAPTER 4

RESULTS

Chapter Overview

This chapter discusses the main results from data analysis that address these major research questions: 1) What are the characteristics and patterns of students' cognitive presence in peer-facilitated AOD? 2) Whether and how the guidance of peer facilitation techniques affects students' cognitive presence? What are the effective peer facilitation techniques that promote cognitive presence? 3) Whether the metacognitive practice affects students' cognitive presence?

Exploration of Cognitive Presence

To learn about the characteristics of students' cognitive presence in the peer-facilitated discussion environment, this study examined: a) the distribution patterns of four phases of cognitive presence; b) the distribution patterns of discussion behaviors across phases of cognitive presence.

Distribution of Cognitive Presence Phases

Content analysis was undertaken to analyze what phases of cognitive presence students demonstrated in their discussion. Four phases were identified: Triggering event, Exploration, Integration, and Resolution. The examples of each type are presented in Table 14.

Table 14: Examples of cognitive presence phases

Phase of cognitive presence	Examples from data
Triggering event	I'm curious, why it wouldn't be beneficial for a student of calculus to reflect on his/her progress? …
Exploration	There is also a great TED Talk on the flipped classroom, given by creator of Khan Academy![information exchange] Hi xx, I agree, change tracking is very helpful, especially if the whole group doesn't agree with one member's changes. [Leaps to conclusions]

	Hi xx, I think blogs and editorials can be good sources, depending on the assignment and depending on the author. [Brainstorming]
Integration	xx a thought occurred to me when I read your statement, "it takes time to learn the technology and time to plan." Well, what if across our country, educational systems were to allow instructors/teachers to design instruction and lesson plans that enabled students to teach technologies that they are already efficient in, and that could be implemented into lesson plans for years to come. I know it's tricky... letting students teach... but if they are more knowledgeable and experienced on, oh, lets say, Google Docs or Twitter, or any other number of tools, then by taking the stage and teaching the class... and the teacher, then the lessons learned by all could be mind blowing. Plus the confidence and self esteem of the students doing the teaching would improve because this would be a tremendous accomplishment for him/her. Additionally, the student doing the teaching would be learning so many new skills; organizational skills, public speaking skills, facilitation skills, listening and question answering skills, teaching skills, etc. I would also imagine that the other students in the class would also be more engaged and excited for the student doing the teaching, that they would then be eager for their opportunity to take the stage and teach something. In fact, I would bet that many of them would be searching their minds to identify existing skill sets so they could volunteer to be the next to teach something. What do you think?… [Build on others' ideas] "I think that investing in technology in schools is important and a must. … Through research and personal experience, I have found that students are more engaged in the content if they are virtually learning it or are experiencing it through some kind of technology. This is true because students are immersed in technology all day, so incorporating it in their learning will benefit them because it is creating a bridge between their daily lives and school. As this week's reading stated, technology can be used for multiple purposes within learning environments. It is a media for inquiry, communication, construction, and expression. Therefore, technology creates multiple opportunities for students to use the skills that they have to help them learn the educational content. " [Integrate different information pieces, reasoning]
Resolution	"… Schoology (www.schoology.com) that I use with all of my classes. ... It has really helped me to manage my classroom business much more efficiently and I really think the students like the ability to access the materials at all times… Schoology is a pre-form site that fits really easily in to classes without a lot of wasted time on decorating. This week, in fact, I asked my seniors to read a few articles about personal statement/college essays and then carry on a discussion on Schoology about the readings. Since they already had this discussion in their head before coming to class, the scaffolding was much less complex and we could jump right into the good stuff. The site also offers an "albums" tools that I opened to students to post class candidates to. Of course, I edit this just in case, but it is a really nice way to create a warm classroom community without a lot of set up hours on my part. The best part is that the only students with a predetermined access code can gain access to the course site, so it is very safe." [Apply, test]

Figure 7 below illustrates the percentage distribution of cognitive presence in the treatment and the control group. Both groups showed a similar pattern. Integration (51.82%, 51.42%) had the highest proportion, followed by Exploration (29.24%, 34.57), Triggering event (14.84%, 10.82%), and Resolution (4.11%, 3.19%). The finding suggested that, in the discussion inquiry, students spent most of the time in the middle phases – Integration and Exploration, but

relatively less time in the initiation phase (Triggering event) and the completion phase (Resolution).

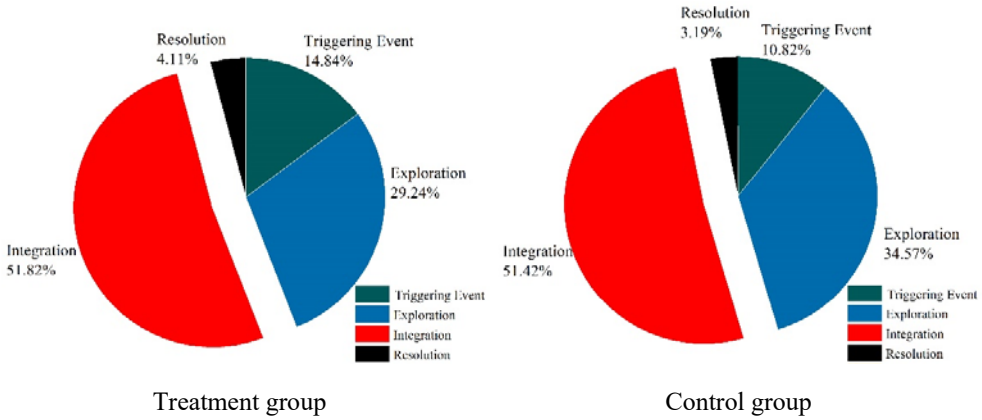


Figure 7. The percentage distribution of cognitive presence phases

The distribution pattern of cognitive presence revealed the learning experience the peer-facilitated online discussion created for students. When a learning community was facilitated by students themselves, they demonstrated active and deep learning. Students were not only able to explore, create, and exchange ideas and information, they were also able to integrate information from various resources, develop justified arguments, and build knowledge upon peers' contributions.

Figure 7 also suggested that there was a lot of room to improve for helping students to achieve Resolution. Among the four phases, Resolution was obviously the least frequent one, which was not uncommon in previous empirical studies (Garrison, et al, 2001; Vaughan, et al., 2005; Akyol & Garrison, 2011; Kovanovic, et al., 2016). This might be due to the fact that weekly online discussion did not ask/encourage students to show their cognitive presence of Resolution. In this study, students were expected to exchange information or develop arguments to share their thoughts on the key issues of integrating technology. However, they were not required to apply and evaluate their ideas in real world. Also, the discussion on each topic only

lasted for one week. It might be unrealistic to assume that all students could apply/test their ideas in that week.

It was quite possible that the pattern of cognitive presence was closely related with the purposes of the learning assignment. The researcher tended to believe that students' cognitive presence might evolve a different pattern and Resolution might become a more prominent stage, if learning objectives of online discussion could explicitly include the performance of application and evaluation, or if more instructional opportunities could be provided to students to help them achieve a particular outcome such as Resolution.

Patterns of Discussion Behaviors Across Cognitive Presence Phases

To further reveal the complexity of cognitive presence, this study also analyzed the explicit discussion behaviors students showed in different phases of cognitive presence. These discussion behaviors, supported by literature, were potential indicators to reflect the different levels/aspects of dialogue-based learning. They included: engagement mode, constructive use of resources, ways of idea collaboration, and use of linguistic features.

Engagement mode

The ICAP framework was used to examine the concrete behaviors that characterized the different levels of engagement. The engagement modes have been defined in Chapter 2. For the convenience of interpreting the results, the definition and examples of each engagement mode are presented in Table 15.

Table 15: Discussion behaviors that characterize different engagement modes

Engagement mode	Discussion behaviors	Examples from data
Interactive_higher	1) being constructive_higher; and 2) interacting with others. This includes elaborating on, pointing to,	Student A: Personally, I have not implemented a lot of web 2.0 technology into my classroom. One issue is time. It takes time to learn the technology and time to plan… Student B: XX a thought occurred to me when I read your statement, "it takes time to learn the technology and

	building upon and challenging their peers' ideas.	time to plan." Well, what if across our country, educational systems were to allow instructors/teachers to design instruction and lesson plans that enabled students to teach technologies that they are already efficient in, and that could be implemented into lesson plans for years to come. I know it's tricky... letting students teach... but if they are more knowledgeable and experienced on, oh, lets say, Google Docs or Twitter, or any other number of tools, then by taking the stage and teaching the class... and the teacher, then the lessons learned by all could be mind blowing. Plus the confidence and self esteem of the students doing the teaching would improve because this would be a tremendous accomplishment for him/her. Additionally, the student doing the teaching would be learning so many new skills; organizational skills, public speaking skills, facilitation skills, listening and question answering skills, teaching skills, etc. I would also imagine that the other students in the class would also be more engaged and excited for the student doing the teaching, that they would then be eager for their opportunity to take the stage and teach something. In fact, I would bet that many of them would be searching their minds to identify existing skill sets so they could volunteer to be the next to teach something. What do you think?
Interactive_lower	1) being constructive_lower; and 2) interacting with others.	Student A: I think to improve the students writing instructors will need to set a hard line between social and academic communication. By separating the two they can show the students what is acceptable and tolerated and what will not be tolerated … Student B: Hi xx, I think your idea of instructors needing to set a hard line between social and academic communication is totally spot on, but I'm curious as to whether you have any thoughts on how to do this? I assume that most students would probably defer from listening to their professors about anything dealing with their social lives, therefore I wonder how exactly teachers might be convincing. What would you recommend the teachers do?
Constructive_higher	Display reasoning through elaborating on a point, explaining a phenomenon, making a cause and effect relationship or comparing two conditions	I believe teachers can successfully use this learning tool in a few ways. One way is to have the blog as a personal reflection on the readings covered in the class. This exercise practices exploration and reflection. If provides the students a place to explore their creative writing skills. Another way to use blog's in the classroom is to practice student generated discussions. Having one student provide a question and others respond is a great exercise to practice construction and collaboration. Also this type of blogging would also provide practice in persuasion witting. Lastly, individual blogs can provide students a place to display their final projects for a class. This is a great chance for students to formulate and design a blog on their own, that displays their project within a theme. This can also be done with group projects, thus influencing collaboration.

Constructive_lower	Propose an idea, ask a question or contains content that is related to the course but go beyond what's covered in the course materials	2. Thoma et. al's "Five Ways to Effectively Use Online Resources in Emergency Medicine" describes how healthcare providers can stay up to date using the Internet. As educators, we are faced with the same challenge. How do you stay current in the ever-changing world of education? What methods have worked for you?
Active_higher	Paraphrase, repeat, and resources mapping, with referring to specific content of course materials	I was just told this week that Homer is going to Google Classroom, too, so I'm super interested in that as well!
Active_lower	Imply attention to course materials, including watching videos, reading textbooks, taking notes, etc., without mentioning what the content is	Love the video you posted! Really informative and gave me a lot to think about.

Table 16 shows the counts of different engagement modes across four phases of cognitive presence. Overall, the majority of engagement modes were constructive (45.60%) and interactive behaviors (44.84%). According to the category definition in Table 15, constructive behaviors occurred in students' private world, while interactive behaviors occurred in a shared space in which students interacted with peers. The percentage pattern indicated that students created their cognitive presence primarily in two ways – individual reflection and collaborative discourse. This finding further supported the PI model's assumption that cognitive presence developed in both private and shared world. This also suggested that instructional activities supporting private reflection and collaborative discourse could help create and develop cognitive presence in online discussion.

Table 16: Counts of combination of cognitive presence and engagement mode

	Active_ lower	Active_ higher	Constructive_ lower	Constructive_ higher	Interactive_ lower	Interactive_ higher	Marginal
Triggering event	2	16	94	71	150	72	405
Exploration	27	206	182	45	392	21	873
Integration	5	21	3	848	1	636	1514

Resolution	0	1	0	82	1	30	114
Marginal	34	244	279	1046	544	759	2906

As shown in Table 16, higher level constructive and interactive behaviors heavily aggregated at Integration and Resolution phase, while others at the phases of Triggering event and Exploration. In particular, at the phase of Triggering event and Exploration, students showed more lower level engagement behaviors, such as showing attention without pointing to the content (Active_lower), repeating or rephrasing existing information (Active_higher), and proposing new ideas without justifying (Constructive_lower, Interactive_Lower). However, at the phases of Integration and Resolution, students demonstrated more higher-level constructive and interactive behaviors in elaborating, explaining, comparing, challenging others, and building on peers' ideas. According to the ICAP framework, interactive mode achieves the highest level of engagement, and it is followed with constructive and active mode (Chi, et al., 2014). The finding from this study provided empirical evidence for the hierarchical relationship among the four phases: Integration and Resolution involved a higher level of cognitive engagement, and Triggering event and Exploration represented a lower level of cognitive engagement.

Constructive use of resource

Four types of resource use were examined: introducing personal experience, introducing expert resource, going beyond by using expert resources to support ideas, and reporting the self-conducted experiments. The examples are presented in Table 17.

Table 17: Examples of the constructive use of resource

Constructive use of resource	Examples from data
Experiment	I have found through the teaching that I am currently doing via athletics that students really like having podcasts available. We have a daily meeting about information that has to do with our upcoming opponent and one thing that our current student athletes have said that they enjoy is being able to retrace their thoughts and rewatch the podcast. I think being able to rewind a few times and ask yourself mental questions is really important. Alot of times students especially as they get older are timid to ask questions because they do not want to

	hold the group up, being able to watch podcasts and rewatch things many times helps those students progress in their learning.
Go beyond expert resource	The Yamagata paper was very interesting and educating as it relates to synchronous and asynchronous learning techniques. Lisa Yamagata did a good job of answering your question of how can integrating synchronous technology into an asynchronous online class benefit students and instructors when she states in her Abstact, … As an adult learner I have had the experience of learning using both synchronous and asynchronous technology so here is, ... I personally prefer asynchronous learning because I like the freedom and mobility it provides. But I do believe the value in synchronous learning can get lost if not used during courses that run over a prolonged period of time. Using only asynchronous technology, students are provided with ample time to develop their opinions and responses, often as a result of surfing the Internet or employing other research techniques. The response is therefore composed, scripted, and in my opinion, does not always represent the true level of understanding of the material being covered in the course. Using synchronous technology and requiring more immediate participation in responding provides teachers with a more accurate measure of the students knowledge and understanding of the material. When the student is required to respond without the benefit of research, they benefit because they know they will have to read and/or study the material in preparation for the discussion therefore, they learn the material in preparation. The teacher benefits because they can get a better understanding of who is doing the work and prepared for class and who is not, based on their responses. This is the teaching and learning benefit.
Introduce expert resource	Yamagata-Lynch talked about setting "ground rules" for an online classroom.
Past experience, life observation	In my experience, adults tend to misuse Power Point, perhaps not to the extent that McMillan satirizes, but definitely enough that audience members tune out and the delivery absolutely impacts the message trying to be conveyed. I teach my 7th graders to not have any text on a slide, with the exception of a title or label. This forces them to really use it as a visual to supplement what they are saying, as opposed to a presentation that we, the audience, will have to read.

Table 18 shows the frequencies of the behaviors in using resources. In general, past experience and life observation (58.09%) was a major resource for students to create cognitive presence. This was not surprising that by doing so the task of discussion could become easier since students made their arguments based upon what they were already familiar with (Caine & Caine, 1991). In addition, the constructive use of personal experience could also help the learning become more meaningful (King, 1994). Thus, to elicit cognitive presence, facilitators could use more prompts in conversation to encourage students to connect their conversation to their past experience, as well as to let them share the related personal stories.

Table 18: Counts of combination of cognitive presence and resource use

	Experiment	Go beyond expert resource	Introduce expert resource	Past experience, life observation	Marginal
Triggering event	9	24	49	100	238
Exploration	0	4	83	225	370

Integration	1	186	37	760	1129
Resolution	107	16	2	7	143
Marginal	117	230	171	1092	1880

The introducing of personal experience gradually increased when they moved from Triggering event to Exploration, and to Integration. At the phase of Triggering event and Exploration, students actively involved in sharing information from internet, readings, or experts. At the phase of Integration, the frequency of simply exchanging expert information decreased, and more higher-level behaviors emerged: students started to go beyond the expert information and they used these resources to support their arguments.

As shown in Table 18, the first three phases, Triggering event, Exploration, and Integration, heavily relied on past experience and life observation. However, Resolution heavily relied on experiment. Conducting experiments was a major method that students could apply and evaluate their ideas. This suggested that, to help students achieve the phase of Resolution in online discussion, instructors could provide more opportunities for them to experiment with the discussed ideas.

Ways of idea collaboration

This study, at the idea level, explored the ways students collaborated to develop their cognitive presence. Five types of collaboration were examined: introducing new ideas, modifying previous ideas, showing agreement, showing disagreement, and monitoring of individual or group progress. Table 19 presents the examples.

Table 19: Examples of idea collaboration

Idea collaboration	Examples from data
Agree	Xx, I agree with your thoughts!...
Disagree	It's hard for me to argue with data, but I'm not sure if I agree with the studies' findings. By researching Podcasting for my blog, I have seen a lot of evidence showing that learning based on different senses is becoming more and more important, so videos, podcasts (okay, I'm biased), music, events, etc. activate those different parts of the brain for learning.
Modify previous ideas	My initial response was similar to some of the other responses so far: that online course aren't as beneficial to me as a learner, mainly because they are missing the definitive piece of

	education that I value, the back & forth discussion between student and professor as well as the discussions amongst students. While that discussion seems to be attempted here, it is far less engaging for me. However, when I read xx's question again, I appreciated her consideration of students with disabilities. I think that removing the barrier of a physical meeting allows all learners, regardless of physical abilities, to participate in higher education. I suppose I would advocate, like xx, that the online classes mirror the traditional face-to-face classes in order to accommodate all learning styles & abilities.
Metacognition	I see that a few of us have come to that conclusion. There are some great conversations happening here already, and it's only Tuesday!! I agree that it is foolhardy to think that we can banish mobile devices inside the classroom…

As presented in Table 20, the major methods students used to collaborate were proposing new ideas (47.00%) and agreeing with / supporting peers' ideas (37.17%). The distribution patterns were similar across phases. At each phase, proposing new ideas was the dominant collaboration behavior. Students were much more likely to show agreement rather than disagreement. Compared to other behaviors, modifying the previous ideas was the least frequent one.

Table 20: Counts of combination of cognitive presence and idea collaboration

	Agree	Disagree	Modification	Meta-cognition	New idea	Marginal
Triggering event	145	45	8	36	322	556
Exploration	549	41	11	103	437	1141
Integration	783	224	40	114	1045	2206
Resolution	33	14	0	8	104	159
Marginal	1510	324	59	261	1908	4062

At the phase of Integration, students demonstrated more collaboration behaviors. The majority of idea modification (67.80%) and disagreement (69.14%) occurred at this phase. The majority of metacognition – the behavior of reflecting on the discussion progress – occurred at the phase of Integration (43.68%) and Exploration (39.46%).

Linguistic features

In this section, an automated linguistic analysis was conducted to explore the linguistic features that characterized each phase of cognitive presence. Use of words is an important indicator of people's social interaction and cognitive process (Tausczik & Pennebaker, 2010).

Therefore, this section examined the linguistic feature by analyzing the use of words that reflect the psychological aspects of students' discussion. Four categories of words were studied, including the words of: a) basic language variable such as the word count (WC), word count per sentence (WPS), number of words longer than six letters (Sixltr), number of quotation and question marks, interrogatives (how, when, and what), and comparison words (greater, than); 2) cognitive process variable such as words of insight (e.g. think, consider), causation (because, effect, hence), discrepancy (should, would, could), tentative (maybe, perhaps, guess), certainty (always, never), differentiation (hasn't, but, else); 3) affective process variable such as words of positive emotion, negative emotion, anxious, anger, sad; 4) perception variable such as hear, see, feel.

The descriptive statistics are presented in Table 21. Pairwise comparisons were made to evaluate the differences. The results are presented in Table 22.

Table 21: Descriptive statistics for word categories across the phases of cognitive presence

		Triggering event (T)		Exploration (E)		Integration (I)		Resolution (R)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Basic language variables	WC	88.57	69.115	60.02	40.360	122.22	58.832	161.81	75.591
	WPS	18.25	6.75	17.51	6.90	21.21	6.57	21.48	5.74
	Sixltr	23.24	7.66	22.13	7.59	22.63	6.07	21.70	5.23
	Question mark	2.48	2.47	0.79	1.71	0.24	0.71	0.12	0.58
	Quotation mark	0.67	1.77	0.42	1.41	0.47	1.18	0.55	1.08
	Interrogatives	2.63	2.15	1.67	1.95	1.62	1.34	1.52	1.21
	Comparison	2.56	2.21	2.99	2.88	3.04	2.05	2.78	1.48
Cognitive process	Cognitive process	17.18	5.94	16.54	6.29	16.59	4.96	14.81	3.82
	Insight	5.01	3.28	4.90	3.48	4.74	2.76	3.80	2.38
	Causation	3.15	2.06	3.22	2.76	3.71	3.04	3.14	1.72
	Discrepancy	2.22	2.17	2.11	2.59	2.18	1.79	1.55	1.25
	Tentative	3.50	2.85	2.98	2.97	3.15	2.13	2.72	1.46
	Certainty	1.52	1.93	1.58	1.41	1.85	2.41	1.58	1.29
	Differentiation	3.70	2.84	3.52	2.94	3.77	2.19	3.64	1.82
Affective process	Affective process	5.09	3.39	6.43	4.59	4.75	2.51	4.67	2.08
	Positive	4.00	3.04	5.42	4.42	3.63	2.24	3.77	1.97
	Negative	0.95	1.80	0.83	1.75	0.95	1.25	0.74	0.84
	Anxious	0.15	0.58	0.15	0.63	0.17	0.44	0.13	0.31

	Anger	0.25	0.85	0.20	0.78	0.21	0.63	0.15	0.40
	Sad	0.13	0.62	0.12	0.66	0.15	0.42	0.10	0.27
Perception	Perception	1.73	1.98	1.83	2.64	1.87	1.73	1.83	1.51
	See	0.60	1.12	0.70	1.66	0.72	1.06	0.86	1.20
	Hear	0.50	1.02	0.57	1.75	0.61	1.05	0.50	0.83
	Feel	0.32	0.82	0.36	1.03	0.37	0.65	0.27	0.47

Table 22: Pairwise comparison of the count of words across the phases of cognitive presence

Word category		BF					
		Tv.s.E	Tv.s.I	Tv.s.R	Ev.s.I	Ev.s.R	Iv.s.R
Basic language variables	WC	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	WPS	4.265	**0.000**	**0.000**	**0.000**	**0.000**	11.900
	Sixltr	1.156	5.268	1.638	6.626	10.738	3.840
	Interrogatives	**0.000**	**0.006**	7.375	26.384	9.393	5.384
	Comparison	0.610	**0.000**	**0.000**	23.458	9.191	9.329
	Question mark	**0.000**	**0.000**	10.099	**0.000**	**0.003**	2.549
	Quotation mark	0.576	0.528	0.727	21.329	8.603	10.321
Cognitive process	Cognitive process	4.903	2.876	**0.005**	28.897	*0.223*	**0.014**
	Insight	17.883	5.567	**0.016**	14.243	**0.064**	**0.026**
	Causation	**0.114**	**0.017**	1.953	24.084	12.686	12.066
	Discrepancy	15.764	20.737	**0.094**	21.699	1.005	**0.016**
	Tentative	0.312	0.601	*0.250*	8.487	8.268	1.420
	Certainty	1.204	17.984	11.525	**0.077**	6.216	13.006
	Differentiation	12.300	19.498	11.662	1.895	11.629	10.799
Affective process	Affective process	**0.000**	1.944	5.538	**0.000**	**0.005**	12.351
	Positive	**0.000**	0.602	8.998	**0.000**	**0.006**	10.562
	Negative	10.562	22.273	5.612	4.655	10.967	2.801
	Anxious	20.781	16.637	11.103	21.048	11.748	7.970
	Anger	12.238	13.803	5.824	26.925	10.276	7.771
	Sad	20.386	19.416	9.885	18.056	11.461	5.824
Perception	Perception	16.292	7.959	10.510	26.619	12.705	12.604
	See	11.732	3.176	1.318	27.339	7.921	5.607
	Hear	15.873	4.256	11.928	23.861	11.759	7.712
	Feel	17.067	10.797	9.971	28.321	8.735	4.032

Students showed distinct patterns in using words and linguistic features at different phases of cognitive presence. Word count showed credible difference between all phases. The discussion posts in the phase of Resolution had the highest word counts. The average word count of a post in Resolution and Integration were more than that in Exploration and Triggering event. Results of word count per sentence and comparison words count showed credible difference between earlier phases of cognitive presence (Integration, Resolution) and later phases of

cognitive presence (Triggering event, Exploration). This observation might be due to the nature of cognitive presence. Exploration and Triggering event are characterized by searching information and producing shallow ideas or questions without justifying. Integration and Resolution are characterized by reasoning, integrating, applying and evaluating. The cognitive processes in the later phases are more likely to involve students in behaviors of elaborating, explaining, integrating, justifying, all of which encourage students to give more details and to piece together various information pieces. In this situation, students would tend to use more words, longer sentences, and more complex linguistic categories (Park, 2009). This finding was consistent with a previous study showing longer writing was associated with a deeper level of reflective thinking (Chen, et al., 2016; Joksimovic, et al., 2014).

The phase of Triggering event showed some distinct use of words in the category of basic language variable. For example, posts in Triggering event used credibly more Interrogatives (how, why, and what) and more question marks. This was because Triggering event was characterized by the behavior of asking question and describing problems. It was also interesting to note that the posts in the phase of Exploration also had more question marks than the posts in Integration and Resolution. A possible reason could be that, at the phase of Exploration, the process of searching information and generating ideas exposed students to new and unknown scenarios that became the Triggering events to stimulate students to ask questions.

Since in Exploration and Integration students were more likely to quote others' statements, the researcher expected the quotation marks would credibly differ between them and other phases of cognitive presence. However, the results were not quite in line with our expectations. There was no credible difference in the count of quotation marks across phases of cognitive presence.

In the category of cognitive process, credible difference was observed between Triggering event and Resolution, and between Integration and Resolution, moderate difference was detected between Exploration and Resolution. It might seem counterintuitive that posts of Resolution used less words that presented the related cognitive process (e.g. cause, know, ought). In Resolution, students used less insight words (think, know, consider) than other cognitive presence phases, and also used less discrepancy words (should, would, could) than Triggering event. This might be due to the fact that students applied ideas in Resolution. Rather than giving personal opinions (think, know, consider, should, would, could), they tended to describe the authentic process of applying ideas, and used empirical evidence to build their arguments.

It was unsurprising that students used more causation words (because, effect, hence) in Integration and Exploration than in Triggering event. Students were more likely to develop causation relationship in building an argument (Integration) and brainstorming ideas (Exploration) than in asking questions (Triggering event). Students also used more certainty words (always, never) in Integration than in Exploration. A possible interpretation of this finding was that, compared to the phase of Exploration where students searched information to learn about the problems and the possible solutions, students in Integration might have already developed their understanding of the studied problem or have proposed a mature solution. Therefore, students in Integration appeared to be more certain about their statements than in Exploration.

The category of affective process revealed a credible difference between Exploration and other phases. Particularly, posts in Exploration used more words of positive emotion. This finding met our expectation. Exploration is more likely to be interesting since exposure to different new ideas makes the experience full of newness and wonder (Garrison & Anderson,

2003). Compared to Integration and Resolution that is more intellectually demanding, the phase of Exploration is more comfortable and enjoyable (Garrison et al., 2001).

The category of perception was also examined but no credible difference was observed for this word category between phases of cognitive presence.

The automated linguistic analysis revealed that each phase of cognitive presence had distinct distribution of a certain categories of words and linguistic features, such as word count, word count per sentence, Interrogatives, question marks, insight words, discrepancy words, causation words, certainty words, and words of positive emotion. These linguistic features could help reveal the psychological characteristics of cognitive presence. At the same time, these linguistic features could also help develop analytic tools that can automatically analyze students' cognitive presence.

Pedagogical Practices to Facilitate Cognitive Presence

This section investigated the effects of two pedagogical practices that aim to facilitate students' cognitive presence: 1) Intervention 1-providing guidance on peer facilitation techniques; 2) Intervention 2-asking students to label their posts in terms of cognitive presence phases. Figure 8 illustrates the implementation of the two interventions.

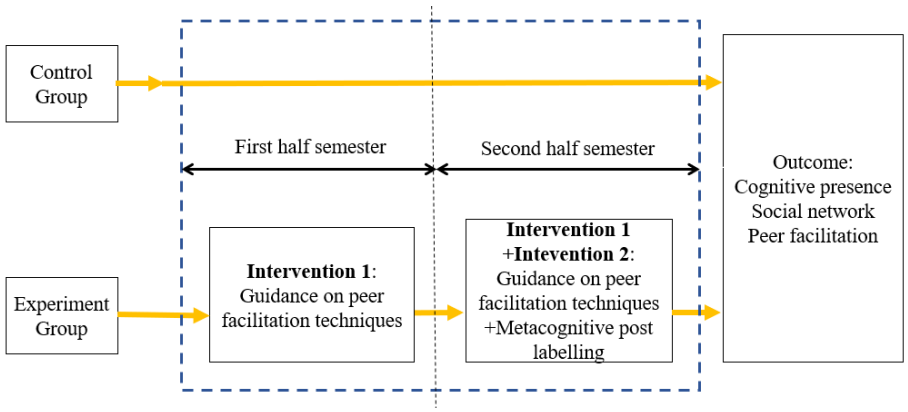


Figure 8. Design of the experiment

The analysis was guided by the framework of Community of Inquiry. Cognitive presence was not studied in isolation but the context of social interaction (social presence) and peer facilitation (teaching presence). Therefore, in addition to cognitive presence, students' social interaction and peer facilitation behaviors were also examined. Multiple comparisons were made to determine the effects of: 1) Intervention 1; 2) Intervention 2; 3) the combination use of the two interventions; 4) the pure practice of discussion. The discussion transcript was the primary data for analyzing the effects of the interventions. Table 23 shows the descriptive statistics of the data set and the number of the occurrence of each type of posts.

Table 23: Description of the data set

Dataset	Triggering event #	Exploration #	Integration #	Resolution #	# of posts
Week 2-14	400	870	1490	114	2557
Week 2-7	173	399	695	53	1188
Week 8-14	227	471	795	61	1369

Providing Guidance on Peer Facilitation Techniques

To determine the effect of providing guidance on peer facilitation techniques (Intervention 1), 2557 discussion posts produced from week 2-14 and 1188 posts from week 2-7 were analyzed.

Analyzing the discussion transcripts from week 2-14. Figure 9 compares the occurrence of four phases of cognitive presence per student from week 2-14 between the treatment and the control group. As shown in Figure 9, students in the treatment group showed more Triggering event, Exploration, and Integration. The occurrence of Resolution was so sparse that the group difference in Resolution could hardly be observed.

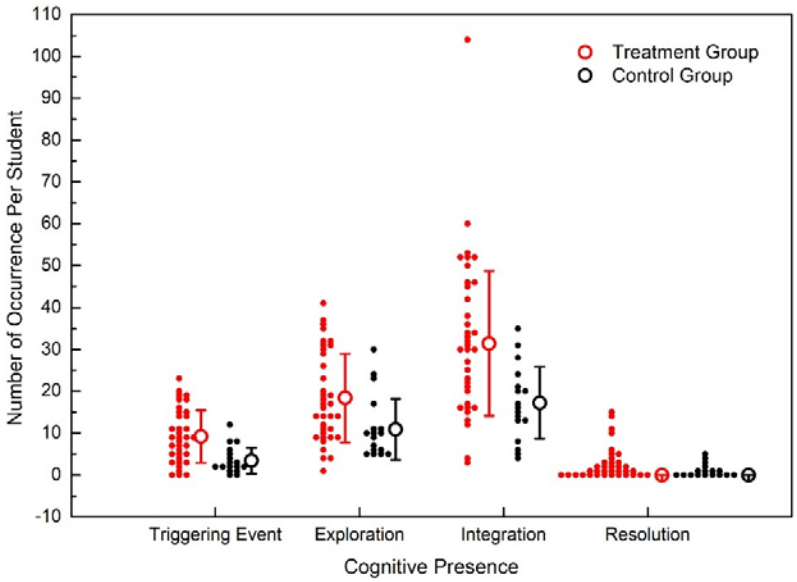


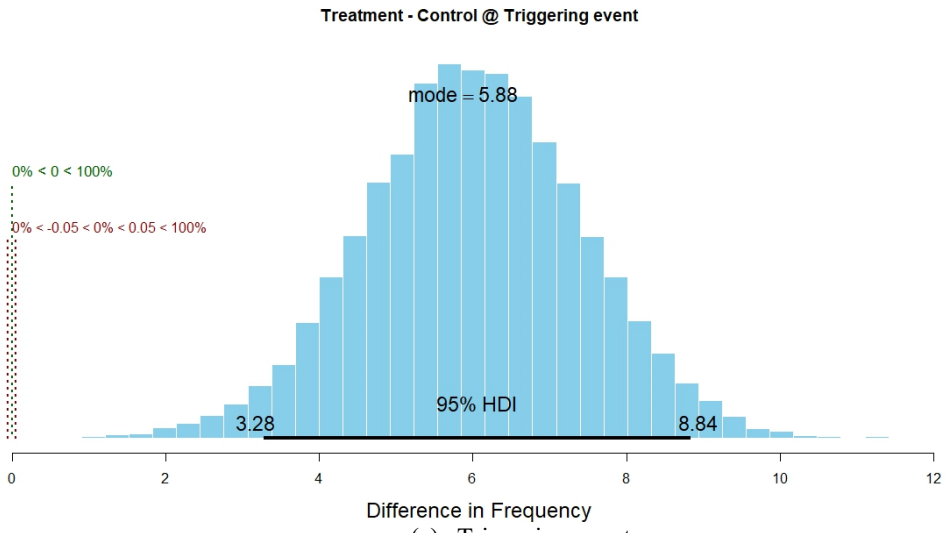
Figure 9. Comparison of the occurrences of cognitive presence per student, data from the whole semester (week 2-14)

ANOVA (2x4 factorial design)[4] was conducted to further examine the group difference in cognitive presence. Since the occurrence of Resolution was too low, the posts of the Resolution type were not metric data. This violated the assumption of ANOVA if using Bayesian approach. Therefore, the researcher decided to not include the Resolution data in ANOVA.

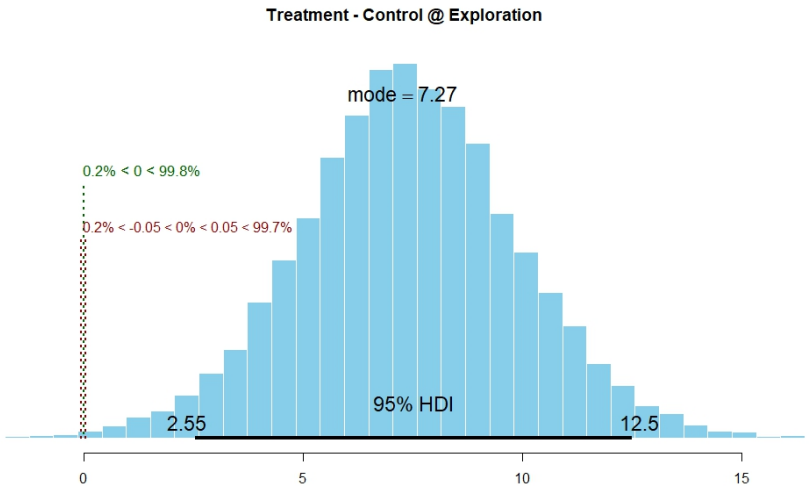
Figure 10 presents the posterior distribution of frequency difference in cognitive presence between the treatment and control group. It revealed great certainty in the estimate of the frequency difference, such that the 95% of credible values – HDI (highest density interval) fell completely above zero. Therefore, we can conclude that the two groups showed credibly different occurrence of cognitive presence of Triggering event, Exploration, and Integration. This suggested that the intervention implemented for the whole semester had a credible positive effect on students' cognitive presence.

[4] Jags-Ymet-Xnom2fac-MrobustHet-Example.R script (Kruschke, 2015) was used to conduct the analysis of 2x4 factorial design.

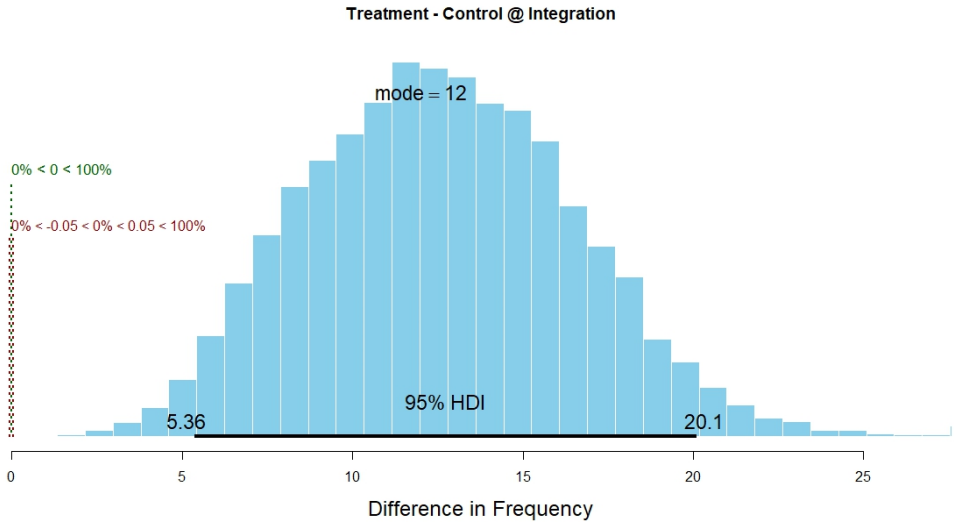
The interventions had a larger effect on Integration than Triggering event and Exploration. By looking at the mode value of the frequency difference, which represents the value that achieved the highest possibility, Figure 10 shows that the frequency difference in Integration (mode =12) was much larger than Triggering event (mode =5.88) and Exploration (mode = 7.27). This suggested that the pedagogical interventions used in this study were especially effective in improving the higher-level cognitive presence – Integration.



(a) Triggering event



(b) Exploration



(c) Integration

Figure 10. Posterior distribution of the group difference in cognitive presence between the treatment and the control group, data from the whole semester (week 2-14)

Analyzing the discussion transcripts from week 2-7. The discussion posts students produced in the first half semester were analyzed to help determine the effect of providing guidance on peer facilitation techniques.

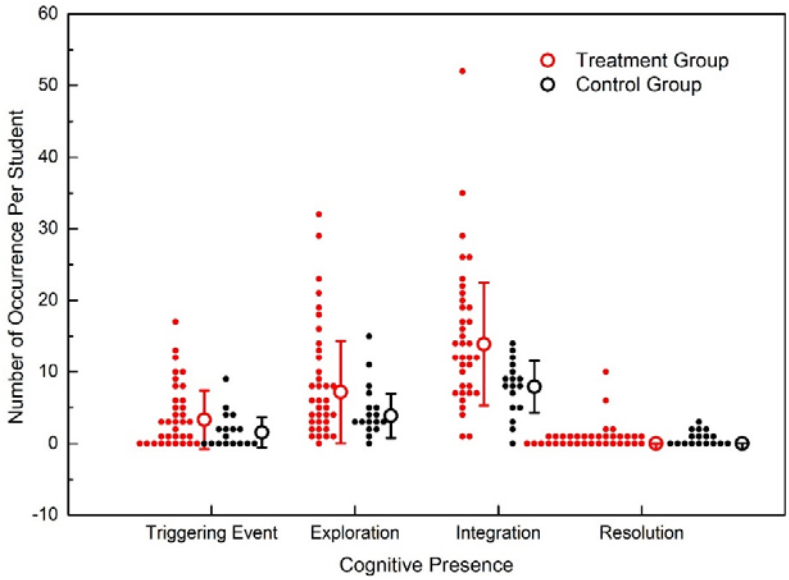
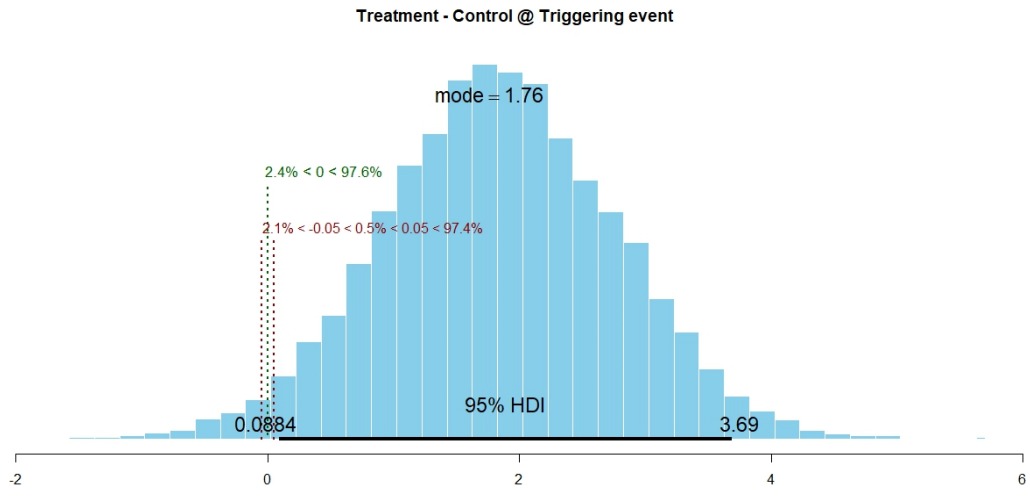


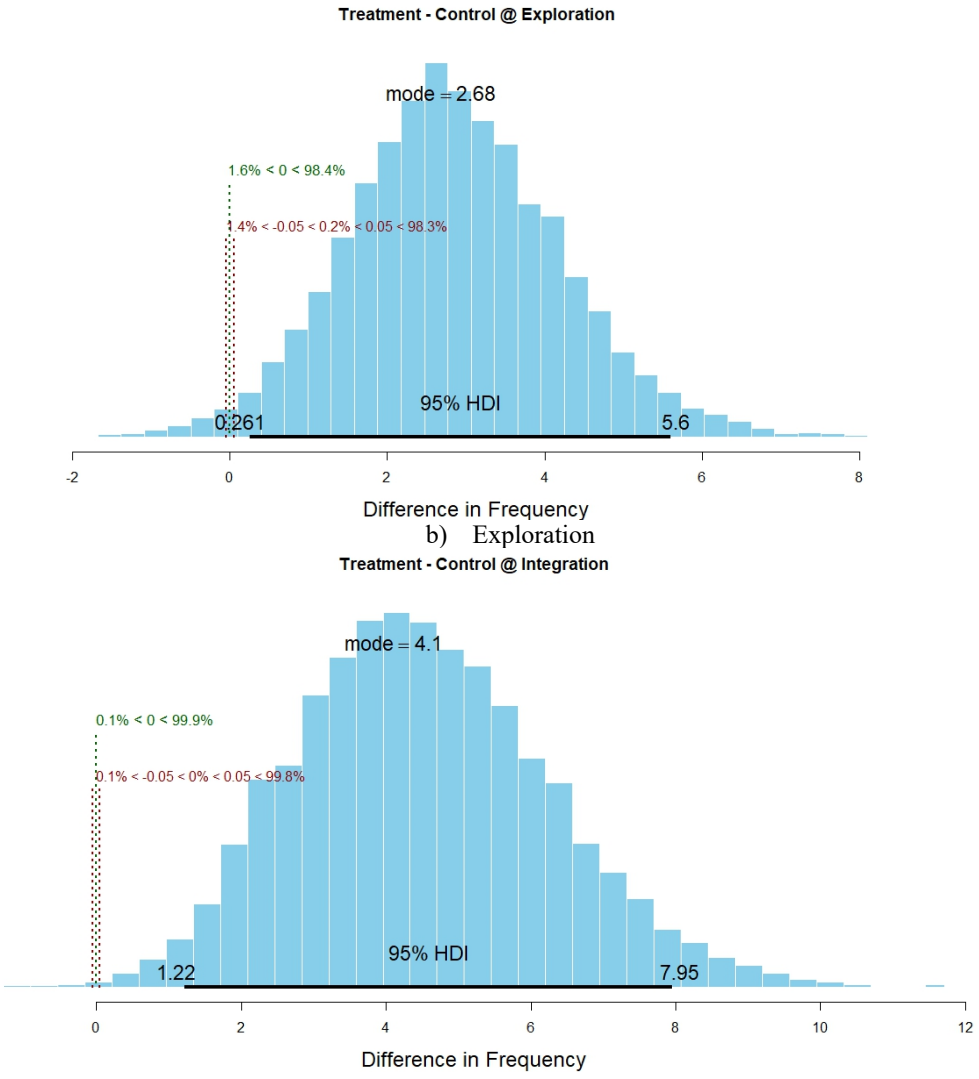
Figure 11. Comparison of the occurrence of cognitive presence per student, data from the first-half semester (week 2-7)

As shown in Figure 11, students in the treatment group demonstrated more cognitive presence of Triggering event, Exploration, and Integration than the students in the control group. The difference between the two group was statistically credible. The result of ANOVA is presented in Figure 12. It showed that 95% of the credible values of frequency difference in Integration, Triggering event, and Exploration were more than zero. This suggested that the Intervention 1-providing guidance on peer facilitation techniques was effective in improving students' cognitive presence.

The mode value of frequency difference was larger in cognitive presence of Integration (mode=4.1) than Triggering event (mode=1.76) and Exploration (mode=2.68). This indicated that the Intervention 1 was more effective in improving Integration – the higher level of cognitive presence.



a) Triggering event



b) Exploration

c) Integration

Figure 12. Posterior distribution of the group difference in cognitive presence between the treatment and the control group, data from the first-half semester (week 2-7)

In short, the discussion transcripts from the whole-semester and the first-half-semester provided evidence that providing guidance on peer facilitation techniques was effective in improving students' cognitive presence, especially for the higher-level cognitive presence (Integration). The analysis on student survey also supported this conclusion. A total of 71.4% of the students agreed that the guidance on peer facilitation techniques was helpful, and 78.5% of

the students agreed that the peer facilitation techniques were effective in facilitating their online discussion.

Asking Students to Label Their Cognitive Presence

To determine the effect of Intervention 2 – asking students to label their cognitive presence, 1188 discussion posts from the first-half semester (week 2-7) and 1369 posts from the second-half semester (week 8-14) were analyzed to compare the occurrence of cognitive presence.

Figure 13 illustrated the change of the posterior distribution of the group difference (between the treatment and control group) in the frequency of cognitive presence. The posterior distribution presented all the possible values of parameters. For the convenience of comparison, the researcher selected the mode value, the value achieved the highest possibility, to compare the change of group difference. As shown in Figure 13, the difference in Triggering event, Exploration, and Integration between the two groups became larger from the first-half to the second-half semester. This indicated that when Intervention 2 was added, the effects of interventions became stronger.

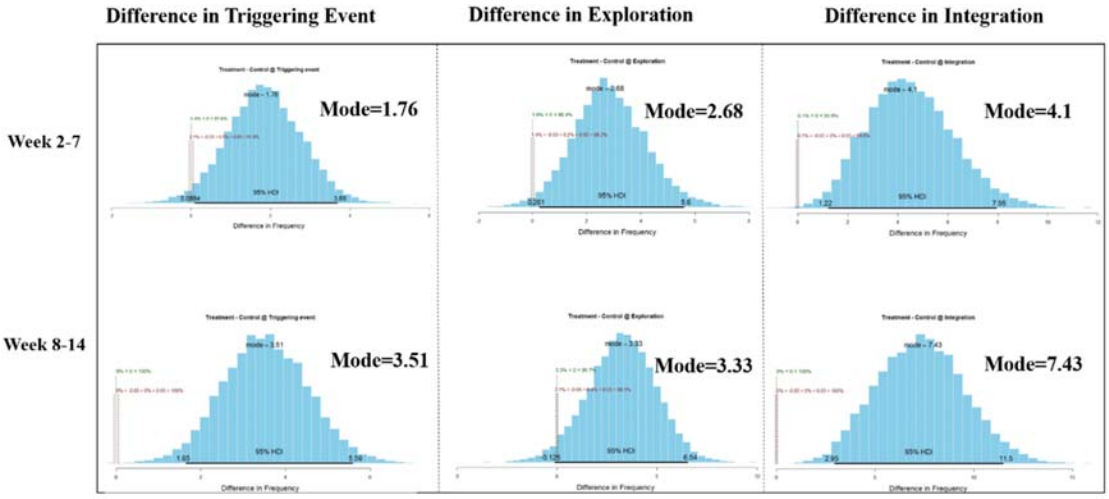


Figure 13. Change of group difference in cognitive presence from week 2-7 to week 8-14

It was also possible that the stronger effects might be due to the pure practice of discussion as time went by. To eliminate this competitive factor, Figure 14 compared the improvement of cognitive presence from the first-half to the second-half semester between the treatment and the control groups. As shown in Figure 14, students in the treatment group showed more improvement in cognitive presence of Triggering event (mode=1.1), Exploration (mode=0.68), and Integration (mode=1.04). The control groups showed less improvement in Exploration (mode=0.68), and almost no improvement in Triggering event (mode=0.0634) and Integration (mode=-0.0394). This suggested that the change of the cognitive presence was unlikely due to the pure practice of online discussion, but because of the Intervention 2.

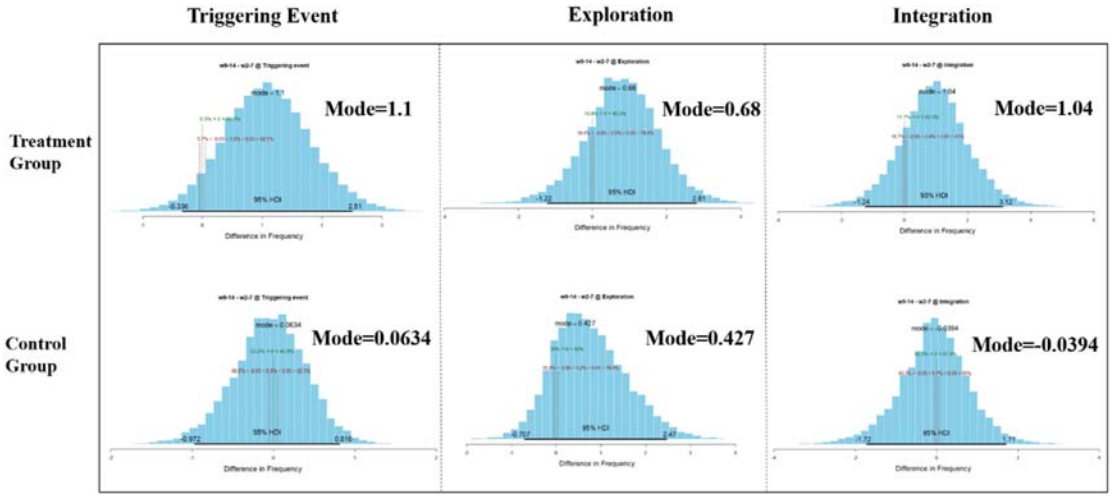


Figure 14. Improvement of cognitive presence from week 2-7 to week 8-14

However, as shown in Figure 14, the cognitive presence improvement from the first-half to the second-half semester was not statistically credible enough to conclude that the Intervention 2 credibly improved students' cognitive presence. The results of the student survey revealed that students' perception on the Intervention 2 was not as good as the Intervention 1. Only 53.6% of the students agreed that this intervention helped them become/stay aware of their cognitive presence, and only 35.7% reported that this intervention helped them showed more higher-level

cognitive presence. These findings were not surprising. In this study, students were asked to change their habit of writing and submitting discussion posts in the middle of the semester. In the Intervention 2, more work load was added to label the posts. Rather than submitting a post right after having finished the writing, they were required to learn about the concept of the cognitive presence, the four phases of developing cognitive presence, and the coding of the four phases. In the second half semester, the occurrence of students' cognitive presence increased, and the effects of the intervention were strengthened for Integration and Triggering event. However, it appeared that, for students, this improvement was not big enough to compensate the cost of creasing the workload. It is quite possible that the weighing between the cost and benefit influenced students' perception on the Intervention 2.

In summary, to investigate the effects of Intervention 2 – asking students to label their cognitive presence, this study compared students' cognitive presence between the first-half and the second-half semester, and between the treatment and the control group. The results showed that Intervention 2 increased students' cognitive presence of Integration and Triggering event, although the improvement was not proved to be statistically credible. The student survey also revealed that students' perception on Intervention 2 was not as good as Intervention 1.

Combination of Two Pedagogical Practices

A total of 1369 posts students produced in the second half semester (week 8-14) was analyzed to examine the effect of the combined use of Intervention 1 (providing guidance on peer facilitation techniques) and Intervention 2 (asking students to label their posts).

As shown in Figure 15, in the second-half semester, the treatment group showed more cognitive presence of Triggering event, Exploration, Integration, and Resolution than the control group.

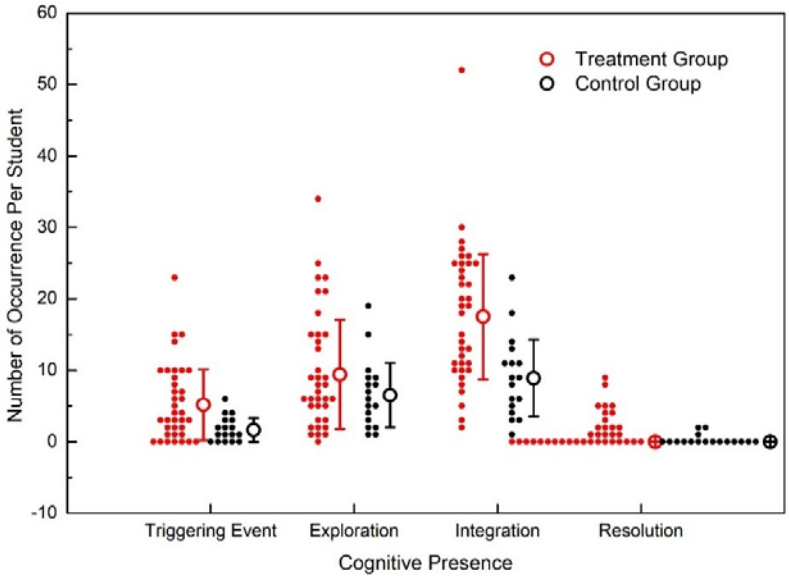
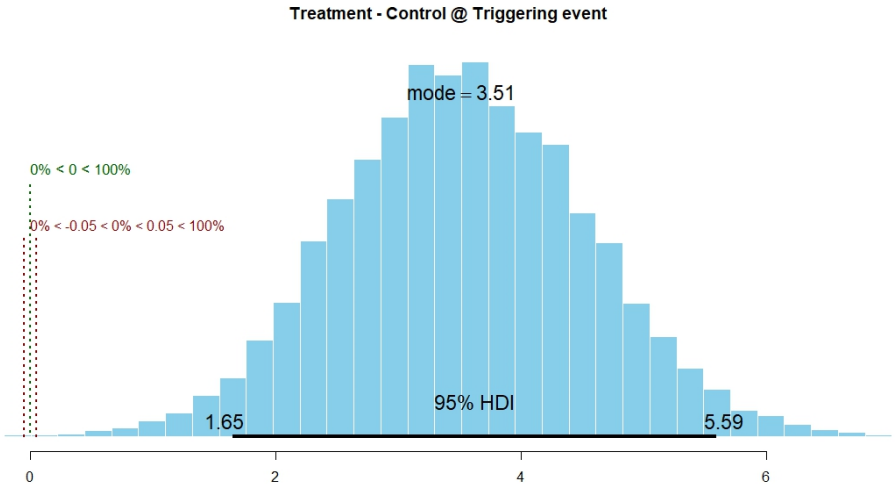


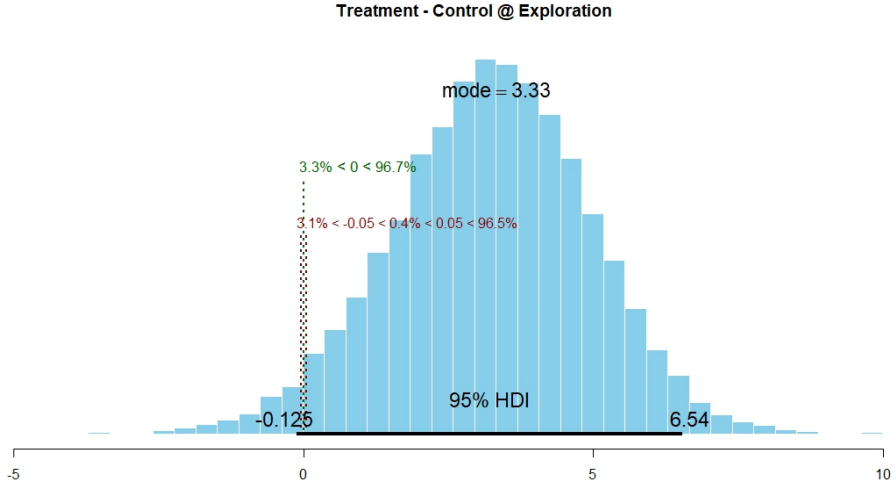
Figure 15. Comparison of the occurrence of cognitive presence per student, data from the second-half semester (week 8-14)

ANONA was conducted to determine whether the group difference was statistically credible. As shown in Figure 16, for Triggering event and Integration, the 95% most credible values of difference in frequency fell completely above zero, which meant that, in the second-half semester, the difference in Triggering event and Integration between the treatment and the control group was statistically credible. As for the cognitive presence of Exploration, zero is among the 95% most credible values, but 96.7% of the possible values were above zero. The researcher tended to believe that the difference in Exploration was marginally credible.

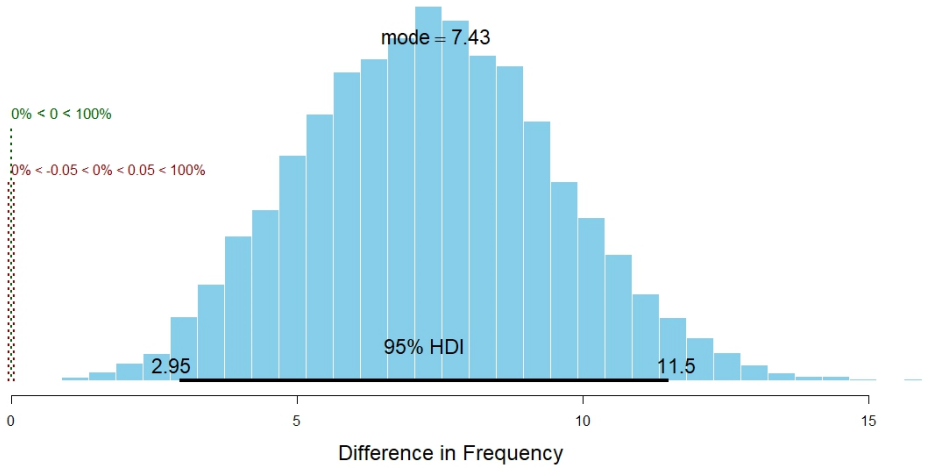
All this revealed that the combination of the two interventions had improved students' cognitive presence. The interventions were especially effective in improving students' Integration and Triggering event.



a) Triggering event



b) Exploration



c) Integration

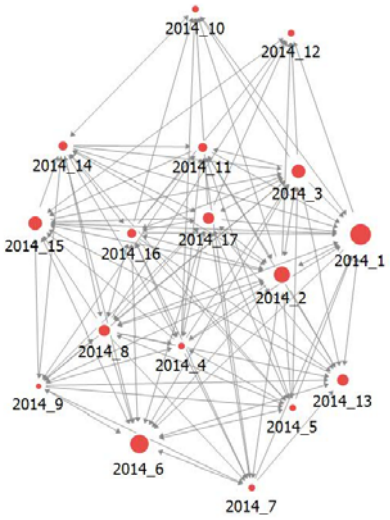
Figure 16. Posterior distribution of the group difference in cognitive presence between the treatment and the control group, data from the second-half semester (week 8-14)

Can Pedagogical Practices Facilitate Social Interaction That Elicits Cognitive Presence?

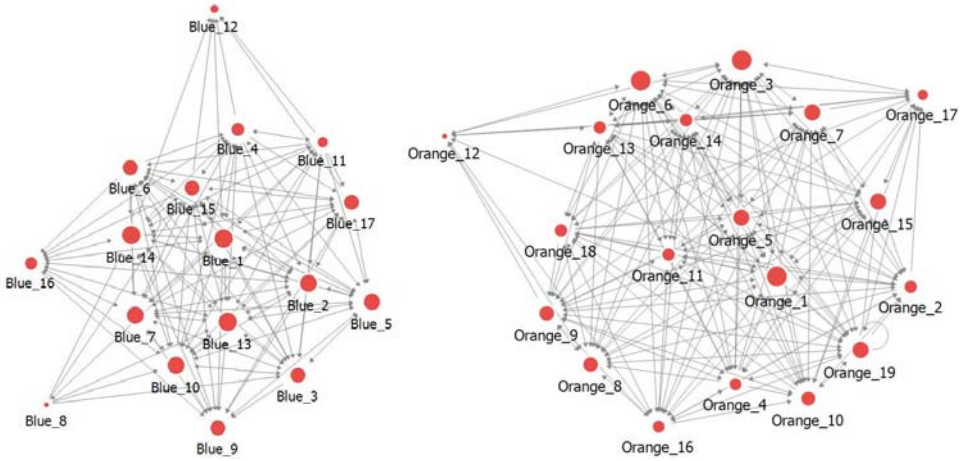
According to the Community of Inquiry framework, cognitive presence arises out of the social interaction among students (Garrison & Anderson, 2003). Cognitive presence is not only a learning outcome, but also a social process that student go through for an inquiry. In this process, students negotiate meaning and develop topics in a reciprocal interactive way. Therefore, it is incomplete to isolate the cognitive dimension from the social dimension. Therefore, the researcher also examined the impact of the pedagogical practices on social interactions that have the potential to elicit cognitive presence.

Providing Guidance on Peer Facilitation Techniques

The graphs of the social networks are presented in Figure 17. In a social network, student individuals are shown as nodes, and the interactions between nodes are shown by lines/links. The size of the nodes and the number of links reflects the number of connections. In online discussion, when a student sends out more messages to the peers, the node size becomes larger; when more social inteactions occur, the number of links increases.



a)Conrtol group (N=17)



b)Treatment group_Blue (N=17) c)Treatment group_Orange (N=19)

Figure 17. Social network graph of the control and the treatment group, data from the whole semester

As shown in Figure 17, there were more larger-size nodes in the networks produced by the treatment groups. This indicated that the students in the treatmeng group were more active in reaching out to connect to their peers. In addition, the networks produced by the treatment groups appeared to be more denser and had more links than the network of the control group. This suggested that more social interactions had occurred in the treatment group. One interesting observation was that students receiving a number of messages were not neccesarily active in replying to peers. This phenomenon was especially common in the control group (e.g., node_2014_2, Node_2014_5).

Table 24 presents the social network measures. The measures included: a) Links: the number of social interactions; b) Density: the number of links divided by the maximum number of all the possible links; c) Average degree: Degree is the number of interactions a node has. In-degree is the number of in-coming links, and out-degree is the number of out-going links; d) Mean distance: the average geodesic distance between any pair of nodes in a network. In a

network, when the distance is smaller, the network is more symmetric and balanced, and the information spread more quickly.

Table 24: Social network measures

Group	Time period	Nodes	Links	Density	Average Degree	Mean Distance
Cotrol group	Week 2-7	17	93	0.342	5.471	1.742
	Week 8-14	17	90	0.331	5.294	1.802
	Week 2-14	17	148	0.544	8.706	1.504
Treatment_Blue Group	Week 2-7	17	132	0.485	7.765	1.520
	Week 8-14	17	148	0.54	8.647	1.482
	Week 2-14	17	193	0.706	11.294	1.294
Treatment_Orange Group	Week 2-7	19	157	0.453	8.158	1.576
	Week 8-14	19	214	0.626	11.263	1.374
	Week 2-14	19	254	0.737	13.263	1.263

To examine the effect of providing guidance on peer facilitation techniques (Intervention 1), the networks from the first-half semester (week 2-7) and the whole semester (week 2-14) were compared between the control and the treatment groups. As reflected in Table 24, all the social network measures achieved better results in the treatment group. The number of links and the density were much higher showing a higher level of connectivity. The average degree was higher indicating studdents in the treatment group were more active in the discussion. The mean distance was smaller in the treatment group implying the networks were more symmetric and balanced so that the information could be spread more easily.

Pairwise comparisons of the social network measures showed that there was statitically credible difference between the treatment and the control group in receiving messages from peers (Degree-in) and sending out messages to peers (Degree-out). As shown in Table 25, for the whole semester, strong evidence showed the credible difference in degree-in, and moderate evidence showed the credible difference in degree-out. In the first-half semester, there was anecdotal evidence supporting the credible difference in degree-in between the treatment and the control group.

Table 25: Pairwise comparison of the degree measure

Comparison group	Degree measure	MD (Mean difference) /BF(Bayes Factor)	Week2-7 v.s. week8-14	Week2-7	Week8-14	Week2-14
Treatment v.s. Control	Degree in	MD	NA	0.126	0.255	0.178
		BF		*0.604*	**0.002**	**0.055**
	Degree out	MD		0.126	0.255	0.178
		BF		1.362	**0.016**	*0.271*
Treatment v.s. Treatment	Degree in	MD	0.173	NA		
		BF	*0.260*			
	Degree out	MD	0.173			
		BF	0.472			
Control v.s. Control	Degree in	MD	0.011			
		BF	3.924			
	Degree out	MD	0.011			
		BF	3.988			

Both the graphs and measures of the social networks suggested that Intevention 1 – providing guiance on peer facilitation was effective in improving students' social interaction. Students in the treatment group were more active in connecting to peers, and they were more active in the online discussion. It was very likely that the guidance of peer facilitation techniques helped the student facilitators demonstrated more behaviors in replying to others' posts or connecting to peers (e.g., asking probing qustions, cue discussions). Also, student facilitators might used the techniques to trigger or maintain the conversation between students (e.g., asking for reponse, invite discussion). All this would result in the increase of interacitons within the networks.

Asking Students to Label Their Cognitive Presence

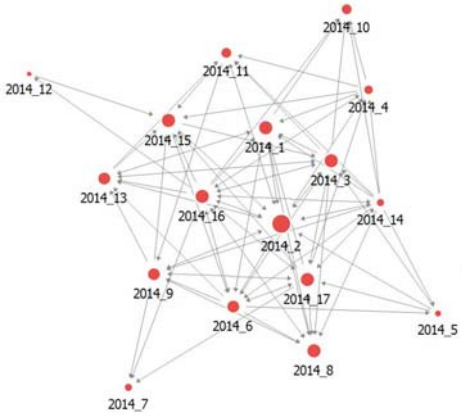
The networks between the first-half and the second-half semester were also compared to reveal the effect of asking students to label their cognitive presence (Intervention 2).

As illustrated in Table 24, the treatment group networks showed an increasing level of interaction or cohesion from the first-half to the seconf-half semester. However, in the control group network, the number of links, density, and average degree all implied a slightly decreasing

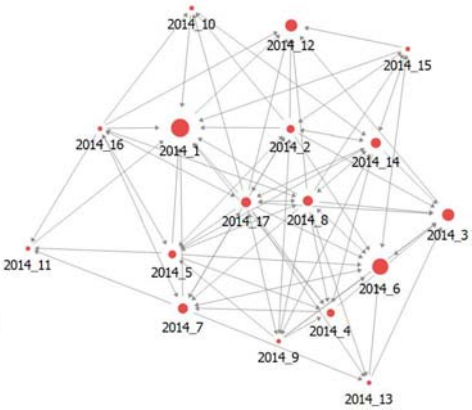
level of interaction. The in-degree measures reported in Table 25 provided moderate evidence that students in the treatment groups became more active in discussions in the second-half semester, and the change was credible. In the control group, as reflected by the in-degree and out-degree measure, no credible change was observed in the number of messgases they received from or sent out to peers.

It was insteresting to notice that the difference between the two groups became increasingly large from the first-half to the second-half semester. The difference evolvement, to some degree, indicated the impact of asking students to label cognitive presence on improving their social interactions.

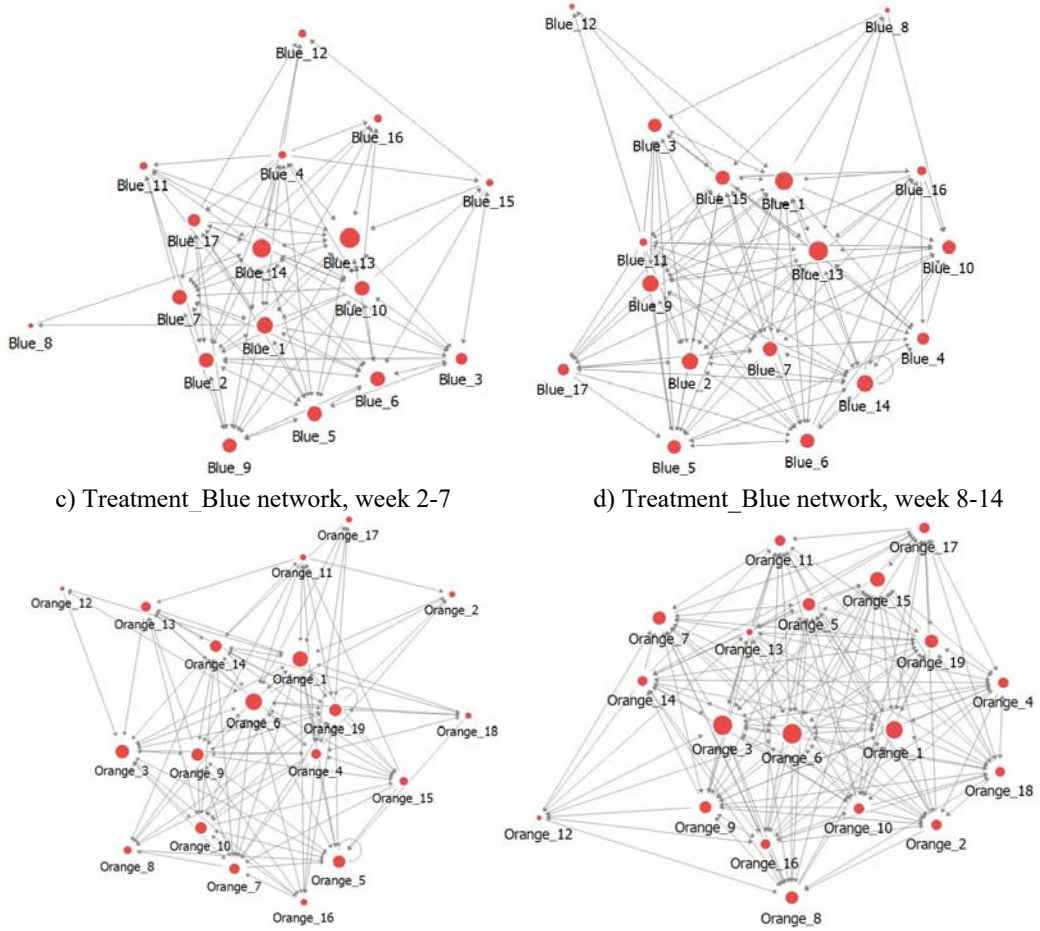
The visualizations of the networks across the two time periods are presented in Figure 18. As reflected by the node size, students in the control group appeared less active in the online discussion when they moved to the seond-half semester. In the treatment group, especially in the Orange group, students became more active in discussion in the second-half semester. The treatment group network became more cohesive since the links between students became denser and balanced from the first-half to the second-half semester.



a) Control group network, week 2-7



b) Control group network, week 8-14



c) Treatment_Blue network, week 2-7 d) Treatment_Blue network, week 8-14

e) Treatment_Orange network, week 2-7 f) Treatment_Orange network, week 8-14

Figure 18. Change of social networks from the first-half to the second-half semester

Taken together, the network measures, the visualisations of networks, and the comparisons across different groups and time periods all provided consistent evidence that asking students to label cognitive presence improved the connectivity of the social networks. One interpretation for this finding is that when students were asked to label their cognitive presence, they were more likely to stay aware of their participation in the online discussion. The indicators of the cognitive presence would encourage them to pay more attention to their interaction behaviors. This awearness and attention may help students increase their interacitons in the online discussion.

Combination of Two Pedagogical Practices

The networks from the second-half semester (week 8-14) were analyzed to reveal the effect of the combination of two pedagogical practices: 1) providing guidance on peer facilitation techniques; 2) Asking students to label their cognitive presence. As presented in Table 24 (see page 140), in the second-half semester, all the network measures in the treatment group outperformed the control group. Table 25 (see page 141) showed the statistically credible difference in both degree-in and degree-out measure between the treatment and the control group.

The results suggested that the combination of two interventions had a credible and positive impact on students' social interactions.

Social Interactions that Involve Cognitive Presence

To further investigate the social interactions that helped create cognitive presence, the researcher compared the interactions that involved cognitive activities. Two levels of interaction behaviors were examined: a) Interaction_higher: students build and develop arguments through interacting with peers. This includes elaborating on, pointing to, building upon and challenging peers' ideas; b) Interaction_lower: students propose new idea, ask questions, or exchange information, but demonstrate no reasoning or explanation, through interacting with peers. The results of the comparison are reported in Table 26.

Table 26: Pairwise comparison of interaction behaviors

	Interaction behavior	Comparison Group	Mean	SD	MD	BF
Week 2-14	Interaction_higher	Treatment	16.28	12.774	10.69	**0.052**
		Control	5.59	5.397		
	Interaction_lower	Treatment	9.53	7.181	5.12	*0.229*
		Control	4.41	4.797		
Week 2-7	Interaction_higher	Treatment	6.50	7.189	4.09	0.495
		Control	2.41	2.320		
	Interaction_lower	Treatment	4.47	5.152	2.53	0.900
		Control	1.94	2.164		

Week 8-14	Interaction_higher	Treatment	9.78	6.573	6.60	**0.011**
		Control	3.18	3.504		
	Interaction_lower	Treatment	5.06	5.099	2.58	0.934
		Control	2.47	3.184		
Treatment	Interaction_higher	week 2-7	4.472	5.152	0.139	5.552
		week 9-14	4.611	5.044		
	Interaction_lower	week 2-7	6.500	7.189	2.139	2.314
		week 9-14	8.639	5.802		
Control	Interaction_higher	week 2-7	2.412	2.320	0.294	3.847
		week 9-14	2.706	3.077		
	Interaction_lower	week 2-7	1.941	2.164	0.000	4.016
		week 9-14	1.941	2.609		

As for the whole semester (week 2-14), the data provided strong evidence that the treatment group showed more higher-level interactions that involved higher-level cognitive presence. The data provided moderate evidence that the treatment group also had more lower level interactions that involved lower-level cognitive presence. This indicated that the pedagogical practices had a positive impact on students' social interactions that involved cognitive presence, especially the higher level cognitive presence.

As for the first-half semester where only Intervention 1 was implemented, the treatment group showed more higher- and lower- level interactions. The data provided anecdotal evidence that the difference was statistically credible.

The combination of the two interventions was found to have effectively improved students' social interactions that involved cognitive activities. As for the second-half semester where Intervention 2 was added, strong evidence was obtained that students in the treatment group had more higher-level interactions. There was anecdotal evidence supporting that the treatment group had more lower-level interactions.

It was interesting to find that although the higher- and lower-level interactions did not change much within both the control and the treatment group as time went by, the difference in higher level interaction between the two groups became greater from the first-half to the second-

half semester. This finding suggested that Intervention 2 did have a positive impact on students' social interactions that involved higher level cognitive presence.

In sum, students not only interacted socially with each other, they also interacted for cognitive activities that helped them build and develop ideas. By comparing these social interactions that involved cognitive activities, the resulted further showed that Intervention 1, Intervention 2, and the combination of the two interventions were all effective in improving students' social interaction that elicited cognitive presence. The effects were especially large for improving the social interactions that involved higher-level cognitive presence.

Association Between Social Interaction and Cognitive Presence

The data provided convincing evidence of a strong association between social interaction and cognitive presence. Student survey, where students were asked to rate their cognitive presence and their social interaction, revealed that cognitive presence was found to positively correlate with their social interaction (Pearson r=0.581, BF=0.038). The analysis of the correlation between degree measure and cognitive presence further supported this finding. The results of the correlation analysis are reported in Table 27. The number of messages students received from peers (In-degree) and sent out to others (Out-degree) were both found to positively correlate with students' Triggering event, Exploration, Integration, and Resolution. As reflected by the Bayes Factors (BF), the data provided extremely strong evidence for the associations between out-degree and Triggering event, Exploration, and Integration, and strong or extremely strong evidence for the correlation between out-degree and the first three phases. Resolution was found to be moderately associated with in-degree, and only anecdotally associated with out-degree.

Table 27: Correlation between social interaction (in- and out-degree) and cognitive presence

			Triggering event	Exploration	Integration	Resolution
In-degree	Pearson Correlation Posterior	Mode	0.536	0.446	0.651	0.397
		Mean	0.515	0.426	0.629	0.378
		SD	0.010	0.012	0.007	0.013
	95% Credible Interval of Pearson Correlation	Lower Bound	0.317	0.206	0.465	0.151
		Upper Bound	0.701	0.634	0.782	0.598
	BF(Bayes factor)		**0.002**	**0.032**	**0.000**	0.117
Out-degree	Pearson Correlation Posterior	Mode	0.646	0.664	0.672	0.331
		Mean	0.624	0.642	0.651	0.315
		SD	0.007	0.006	0.006	0.015
	95% Credible Interval of Pearson Correlation	Lower Bound	0.458	0.480	0.493	0.075
		Upper Bound	0.778	0.789	0.796	0.546
	BF(Bayes factor)		**0.000**	**0.000**	**0.000**	0.479

Students' social interactions involved active cognitive activities. The results shown in Table 27 indicated that when students sent out more messages to others, it was highly possible that they created more cognitive presence in the process of writing those messages. When they received more messages from others, it was more likely that they were encouraged to create or develop their cognitive presence in responding to their peers' messages. This interpretation was supported by the results of the correlation analysis between degree measures and students' behaviors of collaborating on ideas. As shown in Table 28, out-degree was positively correlated with the behaviors of proposing new ideas, modifying existing ideas, agreeing with or supporting an idea, disagreeing with an idea, and reflecting on discussion progress (meta-cognition). The data showed statistically strong or extremely strong evidence for supporting all of these associations. As for in-degree, statistically strong correlations were found between in-degree and all collaboration behaviors but the behavior of modifying ideas.

Table 28: Correlation between social interaction (in- and out-degree) and behaviors of idea collaboration

	New idea	Modification	Agree	Disagree	Meta-cognition

In-degree	Pearson Correlation Posterior	Mode	0.626	0.387	0.557	0.550	0.548
		Mean	0.605	0.369	0.535	0.528	0.526
		SD	0.008	0.014	0.009	0.010	0.010
	95% Credible Interval of Pearson Correlation	Lower Bound	0.431	0.139	0.343	0.334	0.332
		Upper Bound	0.764	0.591	0.717	0.712	0.711
	BF(Bayes Factor)		**0.000**	0.146	**0.001**	**0.001**	**0.001**
Out-degree	Pearson Correlation Posterior	Mode	0.665	0.449	0.747	0.520	0.567
		Mean	0.644	0.429	0.728	0.499	0.545
		SD	0.006	0.012	0.004	0.010	0.009
	95% Credible Interval of Pearson Correlation	Lower Bound	0.485	0.210	0.599	0.296	0.354
		Upper Bound	0.793	0.637	0.846	0.690	0.723
	BF(Bayes Factor)		**0.000**	**0.030**	**0.000**	**0.003**	**0.000**

The analysis of both the student survey and the discussion transcripts revealed the credible positive correlation between social interaction and cognitive presence. The more social interactions students had with peers, the more cognitive presence they created in the discussion. Social interaction created extra opportunities for cognitive activities– students proposing new idea, modifying ideas, agreeing or disagreeing, and reflecting on idea progress. Through involving in these activities, students created and developed their cognitive presence.

Can Pedagogical Practices Facilitate Peer Facilitation That Elicits Cognitive Presence?

The Community of Inquiry framework guided the investigation of the impact of the interventions. This framework outlines the three essential factors of an online educational experience: cognitive presence, social presence, and teaching presence. The three inevitably weave together. Research on any one dimension should be situated in the context of the other two (Garrison & Anderson, 2003). This section analyzed the dimension of teaching presence that was performed by student facilitators.

Peer Facilitation Techniques

The content analysis of discussion transcripts revealed that student facilitators applied six types of peer facilitation in facilitating the discussion. Before comparing the use of the peer facilitation techniques, it would be wise to present the concrete examples showing how students used these peer facilitation techniques. These examples are represented in Table 29.

Table 29: Examples of peer facilitation techniques

Type of peer facilitation	Techniques	Examples from data
Ask question	Ask explanatory questions	You mentioned that your students' work became more meaningful to them as they searched out their interests. Why do you think that is? How can technology facilitate meaningful learning? Can you find any support for your opinion in the Ramos article?
	Ask factual questions	Thanks for sharing, xx! What young people do you work with? Are you a teacher as well? Did the students you worked with in NYC enjoy using the computers iPads?
	Check joint understanding	xx, you mean subscribing digitally, correct? (Vs. a magazine/newspaper/journal subscription that comes in the mail)
Make clarification	Give Logical or Theoretical Explanation	I think that time is very important and tricky, **because** it can be an advantage and disadvantage at the same time. For example, in synchronous communication we can consider it advantage because the feedback is immediate and no waiting time just like you mentioned. Also, it can be a disadvantage that not all students get to participate due to time limits. In asynchronous communication time could be an advantage for all students to participate, but no immediate feedback just like you mentioned
	Give Real-life Examples	I wonder if it's possible to always have "someone available to immediately reach out to for conversation or feedback" with an online course. I once took a course with someone physically in China and they are 12 hours ahead of us! As an instructor I wouldn't want to be having to respond to someone at all hours of the night!
	Create Analogies	But if they are playing on phones, shouldn't they know the potential dangers? I think of it like putting a helmet on a toddler on a tricycle...he isn't going to crash into a wall or a car, but the habit of putting on the protective gear has to begin early. Social media is like a black hole of either good or bad
Promote connections	Cue students' prior knowledge or personal experience	Thanks for sharing, xx! I have heard of Canvas, but I have never used it myself. From your experience, which do you prefer: Canvas or Blackboard?
	Cue class readings	Can you find any support for your opinion in the Ramos article? I think without even knowing it you supported one of Ramos' major points, the "role of the teacher is paramount to the development of critical and creative thinking in the context of blog on-line interaction

	Cue class projects	In our Technology Project (assignment 3), we will be using collaborative technologies. Since we all have such different backgrounds, what are some collaboration tools you have used in other learning/work settings? What are some successes and limitations of those tools?
	Cue previous discussion messages	xx, there have been a few comments about not giving the harasser the satisfaction of acknowledging their efforts. That may work for the single "poison post", but what about a pattern of harassing behavior? This was something I had brought up in a previous discussion thread about how older teachers are "stuck in their ways" a little.
Synthesis & revoicing	Synthesize available ideas	Judy & Sarah (Pseudonym) --I think you are both illustrating the growing trend: children are becoming more adept with technology at a younger age, so how do we go about protecting them? Hi guys, Thank you for your passion for this discussion! According to what you said and my own consideration, I sum up several features about online resources and libraries…
	Revoicing-highlight the important idea(s)	You raised a very sensitive point that students may become disinterested which is true and a problem as well. xx, something you said in the third paragraph is key: those in control need to get out of the way. I find that essential. Not that teachers/trainers are not important (they are); but we need to allow each student to develop and have a love of learning unique to each of them.
	Reflect on the discussion progress	It is interesting to get the point of view from someone who does not like concept mapping. I am really glad that you shard your views and told us about how you feel. Based on numerous posts on the topic of teachers and the standards for personal behavior, we are mostly in agreement that we all need to be more aware of what we're posting online
Provide information	Introducing facts from experience	When I've had students absent for extended periods of time I've often sent them to Khan Academy to learn material I've covered in class.
	Introducing facts from authoritative sources	One of the things that shocked me in the reading was when they talked about the pencil triangles being used for writing .... I would have never thought of this as a piece of "technology" but really it was. In the article, “Teaching with Games- Using Commercial Off-the-Shelf Computer Games in Formal Education,” a teacher said, “Oh I’d lover to use it again. I think there’s so much potential in it (computer games).
	Present alternate/new perspectives	**Student A**: ...for certain courses blogs won't be supplementary knowledge (e.g., calculus--I don't think it makes sense for a beginner in calculus to reflect on his progress or shed new light on a problem). **Student facilitator**: I'm curious, why it wouldn't be beneficial for a student of calculus to reflect on his/her progress? I always thought reflection at any level is critical to moving forward as it helps to enhance meaning and encourage insight. Reflection can often be enhanced by others as well.
	Identify problems	**Student A**: If the society is dealing with something uncontrollable technology then it should make us more cautious in over indulging in it. There are always dos and don't we make as parents and educators to control and educate the children and gradually mature them to be accountable and responsible in all walks of skills and tools that makes their life productive and useful to themselves and to the society. Since we are dealing with an on-line universe, where national boundary does not exist, local norm of law and order may not apply so challenges could be of a global proportion, we must

		need to teach kids the consequences. So tools such as parental/teacher control are going to be of huge importance. And of course with different age group and with different academic set-up it is going to be different. In fact, I think, even being overcautious is not bad. **Student facilitator**: A--I think that you are highlighting a really important piece, that the tools used by parents and teachers to control students/children's online use must be sophisticated and current. **One of the biggest problems** that I have encountered with firewalls and safety measures of that nature is that 1) they are an all-or-nothing block, so that the good is often included with the bad. I am thinking here about my students who, each year, are unable to research "breast cancer" or "the effects of video games" because both the word breast and the term video games trigger our school's firewall. Secondly, the students, definitely by middle school, have figured out how to move around the safety measures that are in place. They always seem to be one or two steps ahead of the adults and so are able to outmaneuver some, if not most, of the controls that we are putting into place!
Use positive social cues	Show agreement, empathy, or shared understanding	I agree with you that there are synchronous elements that can be included in a blackboard site. ABSOLUTELY xx! I laughed as I read your post because that was exactly my experience. I see. Sometimes we just need to gain momentum. No worries, we'll all get there. I promise! I can imagine how frustrating that can be changing your curriculum!
	Praise	You did a great job providing real world examples to support your answer to my question.
	Show thanks	I love your post xx... Thank you for giving us the teacher perspective. I am so pleased to hear you say that you know you are held to a higher standard of conduct because I believe teachers are too.
	Personally invite discussion or invite open discussion	xx, the question I have for you is what piece of technology would be similar for you? I really look forward to hearing what you come up with and to see if it is as difficult for you as it was for me. We had discussions on Internet credibility and had seen and used some instruments to evaluate websites, but have not discussed how to evaluate the credibility of personal broadcasting. I look forward to hearing what everyone will say about this...

Providing Guidance on Peer Facilitation Techniques

Students' peer facilitation behaviors were compared to learn about the effects of providing guidance on peer facilitation techniques. Figure 19 compares peer facilitation between the treatment and the control group by examining the data from the whole semester. The results are reported in Table 30. Students in the treatment group demonstrated more peer facilitation

behaviors than the students in the control group. As shown in Table 30, the differences in the six types of peer facilitation were all statistically credible.

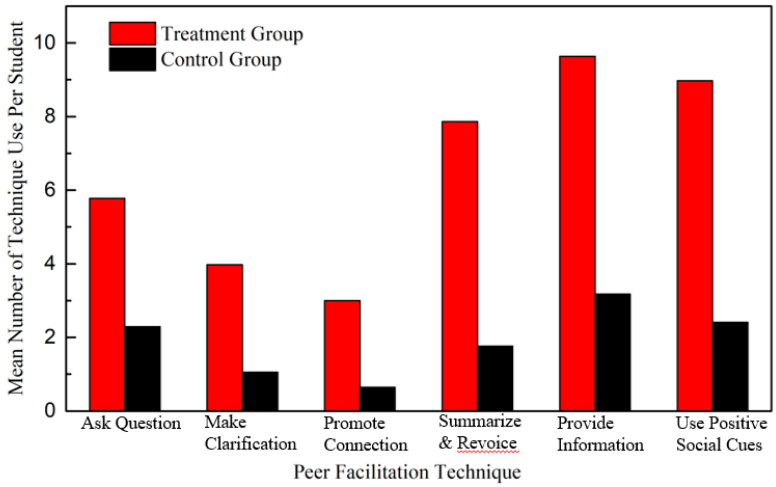


Figure 19. Comparison of the peer facilitation between the treatment and the control group

Table 30: Pairwise comparison of the occurrences of the six types of peer facilitation

	Types of peer facilitation	Comparison Group	Mean	SD	MD(Mean difference)	BF(Bayes factor)
Week 2-14	Ask question	Treatment	5.78	4.162	3.48	**0.002**
		Control	2.29	1.759		
	Make clarification	Treatment	3.97	3.776	2.91	**0.003**
		Control	1.06	1.088		
	Promote connection	Treatment	3.00	3.243	2.35	**0.005**
		Control	0.65	0.786		
	Summarize & revoicing	Treatment	7.86	5.871	6.10	**0.000**
		Control	1.76	2.333		
	Provide information	Treatment	9.64	6.681	6.46	**0.000**
		Control	3.18	3.468		
	Use positive social cues	Treatment	8.97	6.231	6.56	**0.000**
		Control	2.41	2.980		
Week 2-7	Ask question	Treatment	2.33	3.312	1.22	*0.164*
		Control	1.12	1.799		
	Make clarification	Treatment	1.97	3.699	1.56	**0.094**
		Control	0.41	0.870		
	Promote connection	Treatment	1.42	2.545	1.30	**0.042**
		Control	0.12	0.332		
	Summarize & revoicing	Treatment	3.83	5.532	3.30	**0.019**
		Control	0.53	1.125		
	Provide information	Treatment	5.00	7.589	4.00	**0.038**
		Control	1.00	1.904		
	Use positive social cues	Treatment	4.44	6.456	3.68	**0.025**
		Control	0.76	1.640		
Week 8-14	Ask question	Treatment	3.44	4.705	2.27	**0.060**
		Control	1.18	1.629		

	Make clarification	Treatment	2.00	2.818	1.35	**0.061**
		Control	0.65	0.996		
	Promote connection	Treatment	1.58	2.842	1.05	*0.141*
		Control	0.53	0.800		
	Summarize & revoicing	Treatment	4.03	5.868	2.79	**0.065**
		Control	1.24	2.359		
	Provide information	Treatment	4.64	5.743	2.46	*0.112*
		Control	2.18	3.610		
	Use positive social cues	Treatment	4.53	6.059	2.88	**0.070**
		Control	1.65	2.978		
Treatment	Ask question	week 2-7	2.333	3.312	0.833	3.945
		week 9-14	3.167	4.700		
	Make clarification	week 2-7	1.972	3.699	0.139	5.503
		week 9-14	1.833	2.752		
	Promote connection	week 2-7	1.417	2.545	0.028	5.582
		week 9-14	1.444	2.792		
	Summarize & revoicing	week 2-7	3.833	5.532	0.083	5.577
		week 9-14	3.750	5.935		
	Provide information	week 2-7	5.000	7.589	0.778	4.999
		week 9-14	4.222	5.733		
	Use positive social cues	week 2-7	4.444	6.456	0.306	5.478
		week 9-14	4.139	6.109		
Control	Ask question	week 2-7	1.118	1.799	0.059	3.999
		week 9-14	1.059	1.638		
	Make clarification	week 2-7	0.412	0.870	0.118	3.775
		week 9-14	0.529	0.943		
	Promote connection	week 2-7	0.118	0.332	0.294	1.472
		week 9-14	0.412	0.712		
	Summarize & revoicing	week 2-7	0.529	1.125	0.529	2.957
		week 9-14	1.059	2.331		
	Provide information	week 2-7	1.000	1.904	0.706	3.127
		week 9-14	1.706	3.312		
	Use positive social cues	week 2-7	0.765	1.640	0.529	3.296
		week 9-14	1.294	2.779		

In the first-half semester (week 2-7), the treatment group showed credibly more making clarification, promoting connection, summarizing & revoicing, providing information, and using positive social cues. The data provided strong evidence supporting the difference. The treatment group also demonstrated more facilitation behaviors in asking questions, and moderate evidence supported that the difference was credible.

The researcher also compared students' behaviors of using the specific facilitation techniques in implementing each type of peer facilitation. The data from week 2-14 was analyzed, and the results are presented in Table 31. Generally, the use of techniques occurred

more frequently in the treatment group in all cases of peer facilitation techniques. Some of them obtained strong evidence supporting the difference.

Table 31: Pairwise comparison of specific peer facilitation techniques between the treatment and the control groups

Types of peer facilitation	Peer facilitation techniques	Comparison Group	Mean	SD	MD(Mean difference)	BF(Bayes factor)
Ask questions	Ask explanatory question	Control	2.18	1.704	3.18	**0.002**
		Treatment	5.36	3.833		
	Ask factual question	Control	0.12	0.485	0.24	2.283
		Treatment	0.36	0.723		
	Check Joint understanding	Control	0.06	0.243	0.05	3.907
		Treatment	0.11	0.319		
Make clarification	Give logical, theoretical explanation	Control	0.76	0.903	2.60	**0.002**
		Treatment	3.36	3.253		
	Give real-life examples	Control	0.47	0.717	1.06	**0.029**
		Treatment	1.53	1.874		
	Create analogy	Control	0.00	0.000	0.14	2.075
		Treatment	0.14	0.424		
Promote connection	Cue prior knowledge, experience	Control	0.29	0.470	0.79	1.266
		Treatment	1.08	1.857		
	Cue class readings	Control	0.41	0.712	1.03	**0.028**
		Treatment	1.44	1.812		
	Cue class projects	Control	0.00	0.000	0.06	3.723
		Treatment	0.06	0.333		
	Cue previous discussions	Control	0.12	0.332	0.60	1.268
		Treatment	0.72	1.427		
Synthesize & revoicing	Synthesize available ideas	Control	0.12	0.485	0.08	3.888
		Treatment	0.19	0.401		
	Revoicing-highlight the important ideas	Control	1.71	2.339	5.71	**0.008**
		Treatment	7.42	5.659		
	Reflect on the discussion progress	Control	0.18	0.529	1.05	**0.004**
		Treatment	1.22	1.376		
Provide information	Introduce facts from personal experience	Control	1.12	1.536	2.41	**0.021**
		Treatment	3.53	4.018		
	Introduce facts from authoritative sources	Control	0.82	1.185	1.04	**0.043**
		Treatment	1.86	1.885		
	Present alternative/new perspectives	Control	0.41	0.618	1.34	**0.004**
		Treatment	1.75	1.779		
	Identify problems	Control	0.41	0.870	0.20	3.503
		Treatment	0.61	0.871		
		Control	1.53	1.807	4.80	**0.002**

Use positive social cues	Show agreement, empathy, shared understanding	Treatment	6.33	4.269		
	Praise	Control	0.29	0.686	2.73	**0.021**
		Treatment	3.03	3.028		
	Show thanks	Control	1.00	1.696	0.50	3.478
		Treatment	1.50	2.336		
	Personally invite discussion or invite open discussion	Control	0.00	0.000	0.08	2.379
		Treatment	0.08	0.280		

For example, a) in facilitating the discussion, the students in the treatment group asked more explanatory questions for explanation and elaboration. b) To make a clear clarification, students in the treatment group were more likely to give logical explanation and real-life examples. c) In promoting connections, they also tended to perform better in connecting the discussion to class readings. d) They showed more facilitation behaviors of repeating/rephrasing important ideas and reflecting on the discussion progress. e) To provided more supplementary information to the ongoing discussion, students in the treatment group were also more likely to share their own experience, provide information from internet, experts, or readings, and give new or alternative perspectives for their peers' arguments. f) In using the positive social cues to create an open and friendly discussion environment, the treatment group demonstrated more behaviors of giving praise and showing agreement, empathy, and shared understanding.

It was highly possible that the guidance of peer facilitation worked in two ways. On the one hand, the guidance introduced students the information on peer facilitation strategies. By learning about these strategies, they could develop a better pedagogical understanding on how to facilitate the discussion and then became more likely to apply these strategies in their facilitation tasks. On the other hand, the guidance on the peer facilitation techniques might help them become more aware of their involvement in their facilitation. In this intervention, students were also provided with a checklist to record their technique use. Through recording the technique use

during their facilitation, they were encouraged to monitor and reflect on the work they had done. The meta-cognitive awareness of their facilitation performance might also motivate them to apply these facilitation techniques as the discussion was going on.

Both the data from the whole semester and the first-half semester revealed that providing guidance on peer facilitation techniques improved students' peer facilitation behaviors. Students in the treatment group showed more behaviors of asking questions, making clarification, promoting connections, synthesizing & revoicing, providing information, and using positive social cues.

Asking Students to Label Their Cognitive Presence

As for the second-half semester (week 8-14), Table 30 (see page 153) showed strong statistical evidence revealing that students in the treatment group demonstrated more behaviors in asking questions, making clarification, summarizing & revoicing, and using positive social cues. Moderate evidence showed that the treatment group achieved more promoting connections and providing information. However, the difference was very likely due to the impact of Intervention 1-providing guidance on peer facilitation techniques. This conclusion was made because the difference between the two groups did not change much from the first-half to the second-half semester. Also, no credible statistical difference was observed within both groups between the first-half and the second-half semester.

It appeared that Intervention 2 – asking students to label their cognitive presence hardly affect students' performance in peer facilitation. This might be because, in this study, student facilitators were not required to label their cognitive presence when they were facilitating the discussion since the researcher did not want to overwhelm these student facilitators. Student facilitators rarely labeled their cognitive presence, and then they missed the opportunity to reflect

on their cognitive presence in peer facilitation. Thus, it was unsurprising that this study could not find out the impact of Intervention 2 on student facilitators' facilitation behaviors.

Association Between Peer Facilitation and Cognitive Presence

Two types of correlation were examined. On the one hand, the researcher analyzed the association between the use of facilitation techniques by student facilitators and the cognitive presence of all the students. On the other hand, the researcher also analyzed the correlation between student facilitators' facilitation behaviors during the facilitation week and their cognitive presence for the whole semester.

As shown in Table 32, the six types of peer facilitation techniques were all positively correlated to students' cognitive presence. Particularly, the strategy of asking questions, synthesizing & revoicing, providing information, and using positive social cues were all associated with the cognitive presence of Triggering event, Exploration, and Integration. The data provided very strong evidence for these associations. Strong evidence also showed that promoting connections was credibly correlated with Triggering event and Exploration, and moderate evidence showed that it was credibly correlated with Integration. Making clarification was found to correlate with Integration (strong evidence) and Triggering event (moderate evidence). No statistically credible association was obtained between the peer facilitation techniques and the cognitive presence of Resolution. The possible reason could be that the occurrence of Resolution was too sparse to make the association to achieve the credible level.

Table 32: Correlation between peer facilitation techniques and students' cognitive presence

			Triggering event	Exploration	Integration	Resolution
Ask question	Pearson Correlation Posterior	Mode	0.701	0.579	0.426	0.138
		Mean	0.687	0.564	0.413	0.134
		SD	0.004	0.006	0.009	0.012
	95% Credible Interval of	Lower Bound	0.568	0.413	0.230	-0.082
		Upper Bound	0.799	0.709	0.591	0.344

	Pearson Correlation					
	BF(Bayes Factor)		**0.000**	**0.000**	**0.006**	5.367
Make clarifications	Pearson Correlation Posterior	Mode	0.322	0.178	0.643	0.134
		Mean	0.311	0.172	0.628	0.129
		SD	0.010	0.012	0.005	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	0.112	-0.039	0.492	-0.086
		Upper Bound	0.505	0.383	0.756	0.340
	BF(Bayes Factor)		*0.174*	3.281	**0.000**	5.623
Promote connection	Pearson Correlation Posterior	Mode	0.525	0.492	0.323	0.201
		Mean	0.510	0.478	0.312	0.193
		SD	0.007	0.007	0.010	0.011
	95% Credible Interval of Pearson Correlation	Lower Bound	0.345	0.306	0.111	-0.018
		Upper Bound	0.667	0.642	0.503	0.400
	BF(Bayes Factor)		**0.000**	**0.000**	*0.171*	2.344
Synthesize & revoicing	Pearson Correlation Posterior	Mode	0.395	0.603	0.557	0.227
		Mean	0.383	0.588	0.542	0.219
		SD	0.009	0.005	0.006	0.011
	95% Credible Interval of Pearson Correlation	Lower Bound	0.194	0.442	0.385	0.011
		Upper Bound	0.566	0.727	0.693	0.425
	BF(Bayes Factor)		**0.018**	**0.000**	**0.000**	1.503
Provide information	Pearson Correlation Posterior	Mode	0.427	0.626	0.509	0.137
		Mean	0.413	0.611	0.494	0.132
		SD	0.009	0.005	0.007	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	0.230	0.470	0.325	-0.082
		Upper Bound	0.591	0.744	0.655	0.345
	BF(Bayes Factor)		**0.005**	**0.000**	**0.000**	5.467
Use positive social cues	Pearson Correlation Posterior	Mode	0.448	0.605	0.511	0.193
		Mean	0.434	0.590	0.497	0.186
		SD	0.008	0.005	0.007	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	0.253	0.445	0.328	-0.026
		Upper Bound	0.606	0.730	0.656	0.393
	BF(Bayes Factor)		**0.002**	**0.000**	**0.000**	2.650

The results revealed that when student facilitators used more peer facilitation techniques, students were more likely to show more cognitive presence. The correlation between Integration and all six types of facilitation techniques implied the effectiveness of these peer facilitation techniques in improving higher-level cognitive presence. The correlation analysis of the data

from student survey also showed the creditable association between students' perception on peer facilitation they had received and students' evaluation of their cognitive presence (Pearson r=.752, BF=.000).

These findings were consistent with the previous results in this study showing that providing guidance on peer facilitation techniques was effective in improving students' peer facilitation behaviors (the frequency of using peer facilitation techniques) and students' cognitive presence (the number of occurrences of cognitive presence). It was very likely that providing guidance on peer facilitation resulted in the fact that student facilitators tended to use these facilitation techniques, and the increasing use of peer facilitation techniques then led to the improvement of students' cognitive presence.

The association was also examined between student facilitators' facilitation during the facilitation week and their cognitive presence produced during the whole semester (week 2-14). The results are presented in Table 33. Positive correlations were observed between the two. The data provided very strong evidence for most cases. The statistically credible associations were even found between cognitive presence of Resolution and all the peer facilitation techniques but the technique of asking questions. The findings suggested that when student facilitators involved more frequently in applying these peer facilitation techniques in the facilitation week, they tended to show more cognitive presence, including all four phases of cognitive presence, in the whole semester.

Table 33: Correlation between facilitators' use of peer facilitation techniques and their cognitive presence

			Triggering event	Exploration	Integration	Resolution
Ask question	Pearson Correlation Posterior	Mode	0.839	0.567	0.530	0.341
		Mean	0.824	0.546	0.508	0.324
		SD	0.002	0.009	0.010	0.014
	95% Credible	Lower Bound	0.734	0.354	0.308	0.088
			0.904	0.722	0.697	0.554

	Interval of Pearson Correlation	Upper Bound				
	BF(Bayes Factor)		**0.000**	**0.000**	**0.002**	0.395
Make clarifications	Pearson Correlation Posterior	Mode	0.495	0.357	0.749	0.506
		Mean	0.474	0.340	0.730	0.485
		SD	0.011	0.014	0.004	0.011
	95% Credible Interval of Pearson Correlation	Lower Bound	0.262	0.104	0.602	0.279
		Upper Bound	0.669	0.566	0.849	0.679
	BF(Bayes Factor)		**0.007**	*0.285*	**0.000**	**0.005**
Promote connection	Pearson Correlation Posterior	Mode	0.623	0.497	0.670	0.478
		Mean	0.601	0.476	0.649	0.457
		SD	0.008	0.011	0.006	0.011
	95% Credible Interval of Pearson Correlation	Lower Bound	0.428	0.267	0.491	0.243
		Upper Bound	0.763	0.671	0.795	0.657
	BF(Bayes Factor)		**0.000**	**0.007**	**0.000**	**0.013**
Synthesize & revoicing	Pearson Correlation Posterior	Mode	0.617	0.679	0.568	0.354
		Mean	0.595	0.658	0.546	0.336
		SD	0.008	0.006	0.009	0.014
	95% Credible Interval of Pearson Correlation	Lower Bound	0.417	0.504	0.357	0.099
		Upper Bound	0.757	0.802	0.725	0.563
	BF(Bayes Factor)		**0.000**	**0.000**	**0.000**	*0.306*
Provide information	Pearson Correlation Posterior	Mode	0.655	0.700	0.684	0.613
		Mean	0.634	0.680	0.663	0.591
		SD	0.007	0.005	0.006	0.008
	95% Credible Interval of Pearson Correlation	Lower Bound	0.471	0.532	0.509	0.414
		Upper Bound	0.784	0.816	0.805	0.756
	BF(Bayes Factor)		**0.000**	**0.000**	**0.000**	**0.000**
Use positive social cues	Pearson Correlation Posterior	Mode	0.639	0.726	0.628	0.439
		Mean	0.618	0.706	0.606	0.419
		SD	0.007	0.005	0.007	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	0.449	0.568	0.434	0.199
		Upper Bound	0.774	0.832	0.767	0.630
	BF(Bayes Factor)		**0.000**	**0.000**	**0.000**	**0.039**

There were three possible reasons for this finding. Firstly, the task of peer facilitation required cognitive involvement. In using peer facilitation techniques, student facilitators also created cognitive presence. For example, in the process of asking questions for the facilitation purpose, students facilitators created cognitive presence of Triggering event. Secondly, the

guidance on peer facilitation techniques and the practice of using these techniques may help student facilitators stay aware of what they can do to deepen the discussion, as well as help them become more skilled in creating cognitive presence. Even after they completed their facilitation task, they were still very likely to show these behaviors to improve their performance in the online discussion. Thirdly, when served as the facilitator, students facilitators had to read all the posts written by peers, and this was an opportunity for them to learn from others. It was highly possible that the experience of exposing to different perspectives can help them improve their cognitive presence. One facilitator mentioned that "I think I was very understanding of multiple perspectives throughout this week's blogging (online discussion). I really tried hard to look at everyone's responses through their eyes so that my own opinion could be challenged. I think it's important to question our own beliefs so that we become more well-rounded and open to alternate ideas".

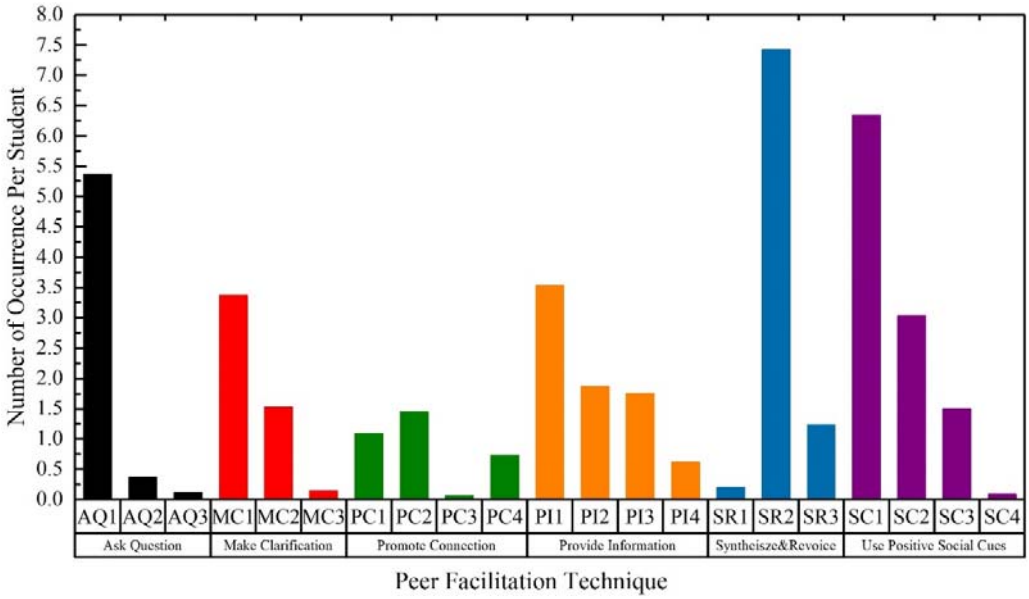
In summary, the peer facilitation techniques– asking questions, making clarification, promoting connection, synthesizing & revoicing, providing information, and using positive social cues– were all effective in improving students' cognitive presence. The results showed that the use of these peer facilitation techniques was positively associated with students' cognitive presence of Triggering event, Exploration, and Integration. It was interesting to find that the use of these facilitation techniques by student facilitators in the facilitation week was also positively correlated with student facilitators' cognitive presence that was showed in the whole semester. This finding suggested that peer facilitation was also a helpful learning experience for students. In using these facilitation techniques, student facilitators did not only facilitate their peers in developing new understanding, but they also helped themselves to improve their own engagement in learning.

How Students Use Peer Facilitation Techniques to Enhance Cognitive Presence

The guidance provided students with the ingredients for effective peer facilitation-the peer facilitation techniques. Students had to develop their own recipe of using and integrating these techniques based on their own teaching philosophy and experience. This section examined how students used the peer facilitation techniques.

Distribution Pattern of Peer Facilitation Technique Use

Figure 20 presents the use of peer facilitation techniques in the treatment group. Among the six types of peer facilitation techniques, the most commonly used facilitation techniques were providing information, using positive social cues, and synthesizing & revoicing. Students also showed active behaviors of asking question, making clarification, and promoting connection.



Note: AQ1:Ask Explanatory Question; AQ2: Ask Factual Question; AQ3: Check Joint understanding;MC1: Give Logical/Theoretical Explanation; MC2: Give Real-life Examples; MC3: Create Analogy; PC1: Cue Prior Knowledge / past experience; PC2: Cue Class Readings; PC3: Cue Class Projects; PC4: Cue Previous Discussion; SR1: Synthesize Ideas; SR2: Revoice; SR3: Reflect on the Discussion Progress; PI1: Introducing facts from experience; PI2: Introducing Facts from Authoritative Sources; PI3: Present New/Alternative Perspectives; PI4: Identify Problems; SC1: Show Agreement/Shared Understanding; SC2: Praise; SC3: Show Thanks; SC4:Invite Discussion

Figure 20. Students' use of peer facilitation techniques (Treatment group)

To implement each type of peer facilitation, they used specific strategies. To provide information, the most frequently used technique by student facilitators was to share their personal experience (36.60%). It was a natural way that student facilitators contributed with something they were familiar with – their background and experience. They shared their own stories to help make their arguments or support peers' ideas. Such personal stories were valuable learning resources that students could learn from each other's past experience. In addition to their stories, student facilitators also showed frequent use of the techniques of introducing authoritative expert resources (19.3%) and giving new/alternative perspectives (18.2%).

In facilitating the discussion, very few employed the technique of identifying problems from peers' arguments (6.34%). It was understandable that students might be reluctant to criticize others in a group discussion. This was because pointing out the problems existed in peers' arguments demanded critical thinking and presented facilitators with the challenge of giving constructive criticism in a way that their peers could feel comfortable with. However, student facilitators still realized that being critical was important in developing students' cognitive presence. One strategy they suggested to use was to encourage students to self-criticize their arguments. When asked to reflect on the peer facilitation in the checklist, one student facilitator mentioned this type of facilitation. (S)he said "cueing self-criticism of classmates' responses (is an important strategy). In some of my responses to classmates' posts which were more emotional rather than reasonably balanced (such as "I still thinks mobiles are distractive in education"), I tried to remember some research that I've heard of (like, Maria Konnikova's research on the "non-existent" multitasking), because I think that being critical to oneself is key to progress… I think it's better to question our general beliefs than not."

Highlighting important ideas through rephrasing and repeating peers' words was an important strategy to summarize the ongoing discussion (94.35%). Not only can this strategy identify the important and promising ideas that might help deepen the discussion, it can also make these ideas more visible to peers. In some cases, this strategy could help discard the potentially distracting topics and direct students' attention to the promising and important ideas. Student facilitators also reflected on and reported the discussion progress (15.55%) and synthesizing all the main points (2.47%). It was interesting to observe that students tended to actively highlight the important ideas as the discussion was going on rather than to summarize all the available ideas in a thread. This finding was less surprising if we consider the time of synthesizing. Facilitators could highlight ideas any time during the discussion, while they had to wait for a certain time period for a certain number of promising ideas to emerge and for synthesizing all the available main points.

To ask initiating or probing questions, the dominant technique students used was asking questions of explanatory nature (92.79%). The questions of this type addressed "how", "why", and "what if", which requested response of explanation and elaboration. Compared to the factual questions that asked for fact information and the questions that checked for shared understanding, explanatory questions were more likely to trigger open discussions that everyone can contribute and thus can keep the discussion from dying. According to Hakkarainen (2002) and Chen et al. (2016)'s studies, explanatory questions were found to have the potential to encourage higher-level integrated and critical thinking.

Student facilitators used several positive social cues to create an open and friendly discussion environment. Among them, showing agreement, empathy, and shared understanding was the most commonly used technique (70.59%). They also expressed their compliment

(33.75%) and appreciation (16.72%) for peers' contribution. Both techniques were important to make the students feel that their ideas were well understood and valued. Student facilitators also personally requested responses from a specific student individual or invite the whole group to open discussions (0.93%). Student facilitators used these techniques to "maintain a positive tone" for developing the discussion. One student facilitator said, "I tried to maintain a positive tone during every discussion so I would not discourage further dialogue or cause tension because of disagreements with commenters."

In making clarification, students were more likely to give an explanation through logical reasoning (84.62%). Using the examples that they had observed from their own experience was also a commonly used strategy (38.46%). Compared to giving logical explanation and providing real-life examples, creating analogies was the least frequently used technique in making clarifications (3.50%).

Facilitators used various techniques to help students build meaningful connections. Among these techniques, constantly cueing class readings was the most commonly used strategy (48.15%). In this course, the discussion activity was designed to let students discuss the weekly readings. The strategy of linking the discussion to the readings could motivate students to read the required readings carefully, make meaningful interpretations from these readings, and help them build robust arguments that were supported by authoritative resources. Also, facilitators encouraged students to connect the current discussion with their personal experience or prior knowledge (36.11%) and with the prior discussions (24.07%).

Overall, students actively used all six types of peer facilitation to facilitate the online discussion. In implementing each type of peer facilitation, they primarily used certain categories of techniques. The use patterns, to some extent, indicated important information about the

effectiveness of these techniques from the perspective of student facilitators. For example, a) student facilitators tended to ask explanatory questions, rather than factual questions, to trigger higher level of cognitive presence; b) they actively made use of their own past experience and prior knowledge in their facilitation; c) they highlighted the important and promising ideas as the discussion was going on to make these ideas more visible to the whole group. While at the same time, the researcher also found some technique that was much less frequently used but was still considered as important facilitation strategies by students. For example, students rarely used the techniques of identifying problems from peers' argument, but they believed that giving constructive criticism was important in helping peers to develop their cognitive presence. Given the challenges of criticizing others, students suggested the strategy of cuing self-criticism.

Combination Use of Peer Facilitation Techniques

The use of facilitation techniques is visualized in Figure 21. Each color node represents a student individual. Clearly, students employed multiple types of techniques in facilitating the discussion, rather than restricted to a certain type of facilitation. This observation was also reported in Chan et al. (2009)'s study which revealed that the combination use of different peer facilitation techniques was more likely to increase the discussion continuity.

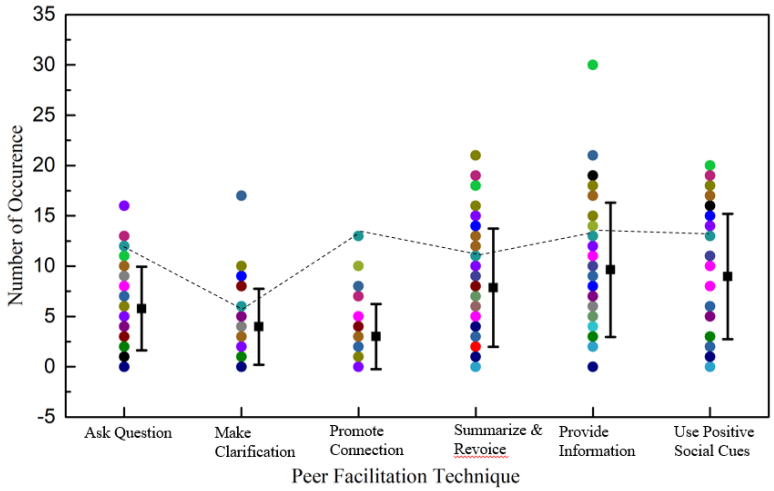


Figure 21. Use of peer facilitation techniques by student individuals (Treatment group)

As shown in Table 34, 89.76% of the facilitation posts used more than one type of facilitation technique. The most common combination was using two (27.36%) or three (41.34%) peer facilitation techniques in one single facilitation post.

Table 34: Number of facilitation techniques used in one single facilitation post

Number of facilitation techniques in one single facilitation post	0	1	2	3	4	5	6
Number of facilitation posts	0	52	139	210	85	17	5
Percentage	0.00%	10.24%	27.36%	41.34%	16.73%	3.35%	0.98%

How the peer facilitation techniques were combined was further analyzed. As reflected in Table 35, all the possible combinations were observed in this study. The examples of combination are presented in Table 38. It was interesting to find that 'providing information', 'using positive social cues', and 'synthesizing & revoicing' were not only the most frequently used facilitation techniques, they also tended to occur together with each other. A very common pattern was that, when responded to a peer's post, student facilitators emphasized the important ideas mentioned by peers (synthesizing & revoicing), pointed out peers' contribution and expressed their agreement and appreciation (using positive social cues), and then provided additional information to supplement peers' arguments (providing information). For example,

> "I really agree with you [using positive social cues]. A sign language interpreter is really important for students who are Deaf or hard-of-hearing [synthesizing & revoicing]. However, many schools refuse to provide the service due to the cost of hiring an interpreter. The teacher can also consider asking other children taking notes, and provide subtitles and transcript as much as possible [providing information]."

The three techniques, ‘providing information’, ‘using positive social cues’, and ‘synthesizing & revoicing’, were also found to be frequently combined with the techniques of ‘asking questions’ and ‘making clarifications’.

Table 35: Frequency of different plural facilitation techniques

Plural peer facilitation techniques employed	Number of occurrences	Plural peer facilitation techniques employed	Number of occurrences
Ask question + Make clarification	38	Make clarification+ use positive social cues	101
Ask question + promote connection	73	Promote connection + synthesis & revoicing	46
Ask question + synthesis & revoicing	88	Promote connection + provide information	85
Ask question + provide information	124	Promote connection + use positive social cues	48
Ask question + use positive social cues	100	Synthesize & revoicing + provide information	168
Make clarification + promote connection	29	Synthesize & revoicing + use positive social cues	224
Make clarification + synthesize & revoicing	75	Provide information + use positive social cues	206
Make clarification + provide information	119		

Table 36: Examples of using plural facilitation techniques

Plural peer facilitation techniques employed	Example from data
Ask question + Make clarification	… You're right. Technology can be slow or problematic in terms of wanting to change the course of the material. For example, in a classroom, an instructor can get the impression first hand if the students are not understanding the material and in that moment, the instructor can pause and clear up the confusion. In an online course, it takes a lot of time to read and interpret student comments or assignments. Online courses leave a lot up to assumption and interpretation. I wonder how an instructor would react if the online course collapsed online - blackboard no longer works, what now?
Ask question + promote connection	Elliot Solloway states "Mobile learning is the transformation from learning what, to learning how!" Please tell us about an experience in which you had to utilize mobile learning in order to complete a task such as tie a bowtie, make poached eggs, hang curtains, or write in cursive. Please include answers to the following questions: Was mobile technology helpful/ useful? Were you able to complete the task with ease? Why/ Why not? What device did you use?
Ask question + synthesis & revocing	I did find your response particularly interesting as you seem to be fairly specific in terms of what content can be effectively blogged and what can not? Did the Ramos article support your opinion? Thanks for the thoughtful response to my question! xx, i like what you had to say about the idea of some students who are involved in virtual universities that chase a degree and not necessarily an education because i also believe that to be true. In this case the numbers will actually go up like you

	said. Do you think in this case that some students take it because they believe that online classes are easier?
Ask question + provide information	xx, when I was in middle and high school, we too would hold assemblies addressing the issue of cyber bullying and harassment. At my school, some of the kids would joke around and not take the assembly seriously. Do you think that these assemblies are effective at your school?
Ask question + use positive social cues	xx, Thanks for your response, i like what you had to say about the idea of some students who are involved in virtual universities that chase a degree and not necessarily an education because i also believe that to be true. In this case the numbers will actually go up like you said. Do you think in this case that some students take it because they believe that online classes are easier?
Make clarification + promote connection	I think you do a great job supporting your thinking with information from the readings! I think the challenge that **Ramos presents in her reading** is one that all instructors face, both in a traditional classroom and online. The real challenge lies in using technology to promote high level thinking versus using it in place of something else. For example, I used to write papers by hand when I was a kid. Now kids word process them. Ok, it's easier, there is spell check but it doesn't make the child a better writer. However, when you introduce that same piece into google docs platform-- kids can offer feedback to one another as well as collaborate and you've stepped things up to higher level. **Have you been in any classes** that effectively used technology to promote higher level thinking? Or have experience using it to promote your own learning?
Make clarification + synthesize & revoicing	**The face-to-face communication is definitely more helpful i will agree with you on that**. The fact that you can get a response right away from a classmate or professor is a huge help in that sense. Confusion can be cleared up right then and there, but i also know that some students dont ask questions in class because they fear of asking a stupid question, in this case i guess you can call the online classes as having an advantage because they can just email the teacher and ask them that way. The time in which they receive a response is something that they will have to deal with but may be preferable and a reason as to why some students take these courses, to avoid things like that. **But like you have discussed this is something that is different for everyone and depends on the type of student.**
Make clarification + provide information	xx, I'm not suggesting that students aren't harassed online, I am just wondering if the overreaction is the response many, many schools have to allowing students to use technology. Students are, **at least in my experience**, consistently warned about the horrendous dangers of predators and identity thieves and then they are blocked from a significant amount of online material. Very little is said about the positive side of social media. It always reminds me of "**abstinence education**" versus "**sexuality education**" with the former being all about the dangers of sex and the latter embracing the positives, while still educating about the very real risks associated with sex.
Make clarification+ use positive social cues	I think **you do a great job** supporting your thinking with information from the readings! I think the challenge that Ramos presents in her reading is one that all instructors face, both in a traditional classroom and online. The real challenge lies in using technology to promote high level thinking versus using it in place of something else. For example, I used to write papers by hand when I was a kid. Now kids word process them. Ok, it's easier, there is spell check but it doesn't make the child a better writer. However, when you introduce that same piece into google docs platform-- kids can offer feedback to one another as well as collaborate and you've stepped things up to higher level.
Promote connection + synthesis & revoicing	xx, **You bring up some interesting points about** Vkontakte as a space for classmates to gather around and get work done but be able to blow off a little steam. **Like you said** it was probably nice because of the fact that you were on it every day and as a form to connect with others but also be able to find information about your class on the same website. Its interesting to see how just the environment in which the class exist makes such a big difference in participation. But where people feel

	more comfortable they will obviously participate more. I agree, (in this course) **Professor xx created a thread in a similar sense** but because it is on Blackboard barely anybody has participated.
Promote connection + provide information	Thanks for sharing your rules, xx. Like Yamagata-Lynch (the class reading) touches, putting the rules upfront is much easier than enforcing them after the fact.
Promote connection + use positive social cues	Great ideas for ground rules, xx! I definitely agree with the one about checking blackboard often. (From the class reading,) The professor in the study seemed to have much success in her class, and it showed in their feedback.
Synthesize & revoicing + provide information	Judy and Sarah (Pseudonym), great discussion (on how to keep students safe online) you've started here! … I also think a lot about how to best keep my students safe online as well as the disparity between those who have access to technology and the Internet and those who don't. My school is launching a one-to-one Chromebook initiative, and while that's great because it'll provide machines to all students, the problem is that Chromebooks are pretty useless without the Internet, and not all students have Internet access at home. That's like giving every kid a cell phone, but no service. I'm worried that this initiative might just highlight the gap between the haves and the have-nots, instead of creating equality, like it was originally meant to. Based on numerous posts on the topic of teachers and the standards for personal behavior, we are mostly in agreement that we all need to be more aware of what we're posting online and I like your comment about all of us should be smart and hold ourselves to a higher standard when it comes to posting on social media. Stuff that we see online is become more and more ridiculous! And we are all being investigated by someone at some point, and we will be held accountable for what we post one way or another... its not all fun and games anymore... there are serious implication's and we have seen them play out many times.
Synthesize & revoicing + use positive social cues	Great analogy xx, "Social media is like a black hole of either good or bad, you can control the situation." How very true! and I agree, people who have the spotlight are scrutinized more often and more publicly than people who don't, so celebrities of all levels have to be extra careful because folks are always watching and the media is always looking for the next big story...
Provide information + use positive social cues	I love your post xx... Thank you for giving us the teacher perspective. I am so pleased to hear you say that you know you are held to a higher standard of conduct because I believe teachers are too. Funny on the superheroes comment. **As for the 1st Amendment rights, as you know, they speak to the laws of the land**. Society creates its own laws as it relates to moral and ethical responsibility and then we debate it in the media... this is the area where many get into trouble. It'll be interesting if the legal system did establish "a clear cut test of... discipline." Whatever it is, it'll be debated as well.

Student facilitators tended to use multiple types of facilitation when responded to a post. The most common combination was using two or three facilitation techniques in one single facilitation post. The concrete examples of the combination were presented in Table 36. The knowledge of how student facilitators combined the facilitation techniques lays a foundation for understanding how students developed their recipe of peer facilitation by using the ingredients – the peer facilitation techniques explained in the guidance.

Cases of Peer Facilitation and Cognitive Presence Evolvement

The content analysis of the discussion transcripts revealed the distribution pattern of students' cognitive presence and their use of peer facilitation techniques. It would be interesting to zoom in on the dynamic process of how cognitive presence evolved and how peer facilitation supported the cognitive presence development. This section investigated the conversation between students by focusing on the discussion threads and episodes. Four threads, which represented the successful/unsuccessful practice of peer facilitation, were presented to show how cognitive presence evolved, and how students used peer facilitation techniques to support the creating and developing of cognitive presence.

Case 1-1: Temporal evolvement of cognitive presence. A discussion thread from the treatment group is presented in Table 37. Four phases of cognitive presence were showed in this thread: Triggering event (T), Exploration (E), Integration (I), and Resolution (R). This section discussed the temporal development of the thread by looking at the occurrence of cognitive presence. The content of this thread was examined in the next section.

Table 37: Discussion thread 1, from the treatment group

Post #	Discussion turns	Note
1	**F**: AQ+PI+PC	F: Facilitator; S1-10: Student 1-10 AQ: Ask question PI: Provide information PC: Promote connection SC: Use positive social cues SR: Synthesizing & revoicing
2	**S1**: R	
3	**F**:SC+SR+AQ	
4	**S1**: I	
5	**S5**: I	
6	**F**: SC+PI+MC	
7	**S2**: E, T	
8	**S1**: E	
9	**S3:** E	
10	**S4**: I, T	
11	**F**: SC + SR +AQ	
12	**S4**: I	
13	**F**: SC	
14	**S2**: I; I	
15	**F**: SC + SR + MC	
16	**S6**: I	
17	**F**: SC + PI + MC	
18	**S4**: I, T	

19	**F**: SC + SR + AQ + PI	MC: Make clarification
20	**S7**: I	
21	**S8**: I	
22	**S6**: I; I	
23	**F**: SC + SR + MC + PI + AQ + PC	
24	**S9**: I	
25	**F**: SC + PI + SR	
26	**S1**: E	
27	**S7**: I; I, T	
28	**F**: SC, SR	
29	**S8**: I	
30	**F**: SC + SR + PI	
31	**S10**: R	

This thread was started by a Triggering event – an initiating question from the student facilitator. However, the thread did not proceed linearly and sequentially. Different cognitive presence occurred sporadically, rather than strictly phase by phase. For example, the Triggering event by the facilitator was immediately followed by Resolution (post#2, 31), Integration (#14, 18, 22, 24, 27, 29), and Triggering event (#18) that were produced by eight students. When the conversation diverged to branches, Exploration (#7, 8, 9, 26), Integration (#4, 5, 10, 12, 16, 20, 21), and new Triggering event (#7, 10) occurred. It appeared that cognitive presence phases occurred spontaneously throughout the discussion process. There was no fixed period unique to one specific phase. Any phases could occur in any sequence. For example, the episode from post # 1-5, cognitive presence developed in the sequence of: Exploration and Triggering event→Resolution →Exploration→Integration→Integration; while the episode including post #2 and #7-9, the sequence was: Resolution →Exploration and Triggering event→Exploration→Exploration. This episode also showed that cognitive presence can recur iteratively.

The four phases of cognitive presence were not exclusive to each other. Multiple phases of cognitive presence occurred in one single post, such as post # 7, 10, 18, 27.

The posts in Table 37 were arranged in the temporal sequence. The thread lasted for one week. One interesting observation was that, at the earlier time of the thread, cognitive presence was created in a bigger shared space-students interacted with both facilitators and peers, and the conversation lasted longer. This was consistent with the observation of peer facilitators. One facilitator mentioned that "It was much easier to engage participants in conversation earlier in the week, versus the end of the week where many people were commenting at once". Based on the researcher's observation, this phenomenon was not uncommon. One possible reason might be the unbalanced distribution of students' posts. One facilitator reported, "on Monday and Tuesday, even Wednesday, there were few comments for me to comment on; then Thursday, Friday and Saturday a plethora came through; however, I did not have sufficient time allotted to respond to everyone". Thus, the posts at the earlier time may have a higher probability to get visible to peers, and also leave their peers more time to process these posts and to give response. It appeared that cognitive presence occurred at the earlier time was more likely to elicit more cognitive presence since the conversion was more likely to sustain at this stage.

In summary, this section revealed the temporal patterns of cognitive presence evolvement. In an ongoing discussion, students' cognitive presence evolved in a non-liner way, rather than strictly phase by phase as suggested by the PI model. There was no fixed period unique to one specific phase. Any phases could occur in any sequence. It was interesting to find that at the earlier time of a discussion thread, the dialogue was more likely to sustain and thus students' cognitive presence was more likely to develop.

Case 1-2: Creating cognitive presence. The episode from post #1-13 was extracted from Table 37. The conversation in this episode is presented in Table 38. The content and the process

of the conversation was analyzed to reveal how peer facilitation supported the creating of cognitive presence.

Table 38: Discussion episode 1, from the treatment group

F: Within the article Posterlet: A game based assessment of children's choices to seek feedback and to revise it states: "A major goal of formal education is to prepare students to be autonomous learners who have the will and the skill to learn without the strict guidance of a parent, teacher, and computer. Independent learners need to make choices with the imperfect information they have at their disposal. For example, students need to choose what and how to learn. In many educational discussions, student choice is seen as a way to increase student motivation and learning during instruction. To what extent do you believe students should have the opportunity to choose how they want to learn? Do you believe that there is a line that needs to be drawn or boundaries that need to be set in place? Do you think this choice will have substantial impact on learning outcomes? Please give your reasons to justify your stands.					
	S1: I believe strongly in choice. In fact, I have designed my classroom to give students as much choice as possible! They choose what to write, what to read...they choose, on a daily basis, how they will spend the 80 minutes of class time, with very few exceptions. The goal, of course, is to create independence, but it does not necessarily translate to increased motivation. The tricky part, of course, is finding the motivating factor for each student so that he or she will then be driven by internal motivation and not by external factors. Existing within a public school, this is difficult. There is a lot of retraining and reframing of what a class "looks" like. Perhaps the biggest obstacle is the Grade (with a purposeful capital G). It is so hard to remove grading from learning in a public school (I'm not even sure that it is possible!), but it is something that I feel really strongly about and strive to do. Autonomy in learning is a mindset that must be reinforced consistently, so that the students ultimately believe that what they choose to learn actually matters. When we tell them that they have control, but then assess their work with a Grade, we are undoing all of the talk that has led them to that point.				
		F: Wow thanks S1 for providing that real life example! I agree that the grade is kind of contradictory if we are promoting students control and exploration. What perhaps would you instate in the place of a grade? How would that look in your class if you didn't have grades?			
			S1: No grades?? My ideal world would have kids reading and writing for authentic purposes. Why do I read? To talk to friends about what I like or don't like and about what I got out of the book. Why do I write? To effect change in some way...but mainly I write so that others will read what I have written, so access to publishing is critical, and is the hardest thing to find for middle school students.		
			S5: Grading is definitely a challenge. When I took a speech class in undergrad, we got to choose whatever topics we wanted, which was really interesting. I gave a persuasive speech on why we should reduce the national deficit according to keynesian economic theory (read: hard core show-off) and received the same grade as the kid who gave a speech on why dogs are better than cats. Still, I think that class was greatly improved by having choice. We were more comfortable talking in front of everyone else on a topic we choose.		
				F: Thanks for incorporating your personal experience S5. I think it is definitely easier for students to be able to be experts in their topic or choice or even be able to articulate it well if they had the opportunity to choose the topic.	
		S2: S1, I think it is great that you let your students choose what they get to write, read, etc. I think it is interesting to read that the hard part is finding the motivating factor for each student. I completely agree with you that it is important that students know what they choose to learn matters. I have not given much thought to the idea that by giving students control and then grading them, undoes the greater goal you are trying to achieve. I wonder how this can be changed?			
			S1: I'm not sure, S2. The one thing that I try to do is assess them on the process and derive a grade based on how they use their time in class (all writing is done in class; none is done outside of the classroom). I think I would be really interested in running an ungraded classroom and seeing how that worked, especially in a public school. It could be really interesting...or a total disaster!		

				S3: Hi, S1, I also think it is great that you let your students choose what they get to write, read. You mentioned you will try to assess students on the process. I was wondering how you will realize it.		
		S4: That sounds really great, S1, and is what I used to want my classroom to look like until these awful Engage NY modules were forced upon us, essentially taking away most teacher and student choice in the English curriculum in my district. Also, Grading with a capital G has always been problematic for me, too, especially in English. To a degree, I understand why we have grades, but I feel like there must be a more effective system to keep students accountable and assess learning.				
				F: Great point S4! While I am not a fan of grades much, I see your point that some mode of accountability should be in place. Can you talk more about Engage NY? How did that hinder choice?		
					S4: My district is mandating that we use the state-produced scripted modules from Engage NY instead of aligning our old curriculum to CC. It's seriously been the worst thing to ever happen to me as an educator. Google Engage NY to view any of the lovely curriculum clearly written by people who have never stepped foot in a classroom.	
						F: Wow! I will google it thanks!

The episode came from a thread that discussed student autonomy in computer-supported assessments. In this context, this episode was initiated by a question of 'to what extent students should have the opportunity to choose how they want to learn? The boundaries and its impact on students' learning?'. This was an interesting and also practical question that students would care about and could very easily relate to in their teaching/coaching. Also, when posing this question, the facilitator connected the question to one of the weekly reading articles and introduced some statements from this article to give background information on where the question came from. In this post, the facilitator used the techniques of asking questions closely related with real life problems, promoting connection to class readings, and providing authoritative information. While at the same time, this facilitator created cognitive presence by exploring the readings (Exploration) and proposing questions (Triggering event).

The facilitator also asked students to give reasons to justify their stands. This conveyed a message that cognitive presence of Integration or Resolution was expected in their responses. This strategy worked. As shown in Table 39, the immediate responses followed this question all showed higher-level cognitive presence (see post #2, 14, 18, 22, 24, 27, 29, 31).

After the question was posed, a student quickly provided a real-life example. S1 shared how (s)he applied the idea of letting students make choice in her/his classroom. (S)he explained how this idea was implemented – "They (Students) choose what to write, what to read...they choose, on a daily basis, how they will spend the 80 minutes of class time, with very few exceptions". Then S1 went beyond simply describing what happened in the classroom. (S)he became reflective and critical to point out this could help "create independence, but it does not necessarily translate to increased motivation". And then (S)he came up with an explanation on why "finding the motivating factor" was important but it was difficult in her/his working environment – a public school, and why grading was an "obstacle" in the process of giving students autonomy. In this process, S1 created cognitive presence of Resolution.

Later, the facilitator acknowledged S1's contribution of sharing a real-life example and (s)he highlighted the important idea S1 mentioned – "the grade is kind of contradictory if we are promoting students control and exploration". This solicited a response from a student S5. S5 provided her/his story to support this idea (Integration). Alone this line, the facilitator asked a 'what-if' question: "How would that look in your class if you didn't have grades?". This question served to maintain the discussion and also to push S1 to re-think about the role of grading. S1 responded with "No grades??". The two question marks might indicate S1 admitted that though grading was an obstacle for student autonomy, but it was not practical to exclude it from the class especially in a public school. S1 then explained the ideal situation in her/his eyes: students studied for an authentic purpose (but not only to get grades) and why this was important. S1 created cognitive presence of Integration by answering the facilitator's what-if question. The initiating question triggered S1's response that was situated in a real-life context, and after S1's

post, more conversations started to emerge between and among students such as S2, S3, S4, and S5.

S4 felt resonance in S1's post. (S)he depicted a very similar problem scenario in her school district. In addition to agreeing with S1's idea of encouraging autonomy and using more effective assessment, S4 built on S1's post by using her/his experience to extend the discussion topic from student autonomy to teacher autonomy in class (Integration). In this post, S4 introduced new information on "Engage NY modules" and pointed out that it took away teacher's autonomy. Then the facilitator asked S4 to "talk more about Engage NY" and to explain "How did that (using scripted modules from Engage NY) hinder choice (of teachers)?". This was an explanatory probing question to encourage students to elaborate and to show reasoning. After this question, S4 gave her/his explanation (Integration): teachers were forced to use scripted modules that were written by people who had limited teaching experience in classrooms.

As reflected in Table 37, the facilitator actively asked questions to engage students into the conversation, and frequently replied their posts to maintain the discussion. According to Kennedy (2004), this is a fundamental move of a facilitator to prevent the discussion from dying. A certain number of posts are needed before an online discussion moving to a higher level of knowledge construction (Schellens et al., 2005). Facilitators' posts well served this purpose. As a member in the group discussion, facilitators co-inquired with their peers. In addition to asking probing questions, they also provided their clarifications or explanations to supplement peers' arguments. For example, when S5 reported her/his observation that "class was greatly improved by having choice", the facilitator explained the possible reasons behind this observation "it is

definitely easier for students to be able to be experts in their topic or choice or even be able to articulate it well if they had the opportunity to choose the topic".

Table 39 illustrated a discussion thread on the same topic by the control group. The comparison between Table 38 and Table 39 showed that the facilitator in the control group (thread 2) involved less frequently than the facilitator in the treatment group (thread 1). In facilitating the discussion, the facilitator in the thread 1 used a variety of peer facilitation techniques and actively asked followed up questions to request responses from students. However, the facilitator in the thread 2 repeatedly used the techniques of providing information and using positive social cues (show thanks and agreement), and did not ask any probing questions. By looking at the facilitation posts, it appeared that the treatment facilitator was more likely to be able to elicit responses from students. This indicated that the treatment facilitator facilitated more creating of cognitive presence. Also, although the number of students in the thread 2 was higher, more higher level of cognitive presence (Integration, Resolution) was observed in the thread 1.

Table 39: Discussion thread 2, from the control group

Post#	Discussion turns	Note
1	F： AQ + PC + PI (E, T)	
2	S1： E	
3	S2： E	
4	S3： I, T	
5	F: SR + SC + PI (E)	
6	S4: I	
7	S5: I	
8	S6: E	
9	S7: E	
10	S8: I	
11	S9: E	
12	F: PI + SC	
13	S10: E	
14	S11: I	
15	S12: I	
16	F: SC (E)	
17	S11: E	
18	S5: I	
19	F: PI + MC (I)	
20	S7: I	

F: Facilitator;
S1-13: Student 1-12
AQ: Ask question
PI: Provide information
PC: Promote connection
SC: Use positive social cues
SR: Synthesizing & revoicing
MC: Make clarification

This case demonstrated how student facilitators used facilitation techniques to help students create cognitive presence. Student facilitators in the treatment group tended to use a variety of peer facilitation techniques that were suggested by the guidance, such as asking questions, highlighting the important ideas, and promoting connections, etc. In discussions, they strategically integrated these techniques. For example, a) When asking question, they kept asking questions that were closely related with real-world teaching needs and situations. This helped promoted students' interests and motivation to get involve; b) They explicitly gave prompts in conversation to ask students to explain "why" and "how". This elicited more higher-level cognitive presence; c) Student facilitators identified and tracked the important contributions made by students by restating the ideas, asking for elaboration on missed information pieces, and directing the discussion from the surface narrative to a deeper level of critical thinking; d) Cued weekly readings, and quoted important and inspiring statements to supplement the discussion. Compared to the facilitator in the control group, the facilitators in the treatment groups showed more facilitation behaviors, and his/her facilitative moves were more likely to elicit students' response and dialogues.

Case 2: Developing cognitive presence through dialogues. In this case, a distinctive feature of the discussion thread was the continuity of the conversation among students. In this thread, students were more likely to have dialogues with peers and to speak based on previous posts. As reflected in Table 40, several smaller groups of discussion were observed. For example, there were multiple layers of replying posts following the post #2, 6, 11, 18, 22, 25, and 33. The facilitator actively participated in these dialogues. All six types of peer facilitation were showed.

In most cases, the facilitator's posts received responses from students, and this helped the dialogue to continue. Students showed four types of cognitive presence and frequently demonstrated higher level of cognitive presence (Integration, Resolution). As the dialogue occurred and sustained, the content of students' posts was building on their peers' posts. It was very likely that students' cognitive presence developed as the dialogue moved forward.

Table 40: Discussion thread 3, from the treatment group

Post#	Discussion turns	Note
1	F: PI + AQ + PC (E, T)	
2	S1: I	
3	F→S1: PI + MC + SC (I, T)	
4	S2→F: I	
5	S3: I	
6	S4: I	
7	S1: I	
8	F→S1&S4: SR + SC + AQ (I, T)	
9	S4: I	
10	S5: I	F: Facilitator; S1-13: Student 1-13 AQ: Ask question PI: Provide information PC: Promote connection SC: Use positive social cues SR: Synthesizing & revoicing MC: Make clarification
11	S6: I	
12	S7: E, T	
13	F: PI + SC + MC (E)	
14	S7: I	
15	F: SR + SC (E)	
16	S8: E	
17	S9: I	
18	S10: I	
19	F: SC + SR + PI (E)	
20	S11: I	
21	S8: E	
22	S12: I, T	
23	F: SC + SR + PI (E)	
24	S6: I	
25	S3: I	
26	S8: E	
27	F: SC + PI + AQ (E, T)	
28	S8: I	
29	S5: E	
30	F: PI + MC (I)	
31	S9: I	
32	F: SC + SR + PI (I)	
33	S5: R	
34	F: MC + PI + SR + SC (I)	
35	S2: I	
36	F: AQ + SR (E, T)	
37	S13: I	

The discussion thread on the same topic from the control group is presented in Table 41. Compared to Table 40, the thread in Table 41 showed much less dialogues among students. In most cases, students came in the thread to post their answer to the initiating question, and then leave without interacting with others. In this situation, the discussion forum became a place where students merely submitted their assignments rather than a community where they could collectively learn and inquire. Since there was not much dialogue, the control group (thread 4) did not have as much chance as the treatment group (thread 3) to develop cognitive presence.

Table 41: Discussion thread 4, from the control group

Post#	Discussion turns	Note
1	F: PI + AQ + PC	
2	S1: I	
3	S2: E	F: Facilitator
4	S3: I	S1-13: Student 1-13
5	S4: E	AQ: Ask question
6	S5: I	PI: Provide information
7	S6: I	PC: Promote connection
8	S7: I	SC: Use positive social cues
9	S8: I	SR: Synthesizing & revoicing
10	S4: I	MC: Make clarification
11	S9: E, T	
12	S10: I	
13	S11: E	
14	S12: I	
15	S9: I	
16	S13: I	

Now, I examined the content of the discussion to reveal how peer facilitation helped the dialogue to move forward. As presented in Table 42, similar to the thread 1, the facilitator initiated the discussion using the techniques of asking questions, providing information, and promoting connection to the class readings. Based on a statement from the class reading, the facilitator asked a debating question of ‘whether 9-12 years old is the best age to begin cyber ethics instruction’. (S)he also provided some statistic information on the age of children using digital technology.

Table 42: Discussion episode 2, from the treatment group

F: In the article, "The Cybercitizen Partnership: Teaching Children Cyber Ethics," Dr. Marvin Berkowitz concludes that 9-12 year olds are the target age to begin cyber ethics instruction. He basis his conclusion on a number of variables. Do you agree that this is the best age or is it too late? Consider that in 2015, more than 30% of U.S. children first play with a mobile device when they still are in diapers, according to Common Sense Media. Furthermore, almost 75% of 13- to 17-year-olds have smartphones, and 24% admit using their phones almost constantly, according to the Pew Research Center.				
	S1: I agree with this conclusion. I think 9-12 years old is a good target age to begin cyber ethics instruction. I think this is a good age because kids use the computer a lot and they need to be aware of the dangers that the internet holds. Dr. Berkowitz even said that "this age range is considered a "gateway" age. The 9-12 age is also the point in development where children begin to understand abstract values, for example privacy rights, and can begin to evaluate the consequences of their actions." If children can understand privacy issues than they need to be aware of the dangers of the internet, how they can protect themselves, and what the consequences are for certain actions. I think the first time I learned about these cyber ethic issues was in sixth grade health class when I was 11. I think it was a good age to learn about it in school and think it is important to educate students on these issues sooner than later. As students get older, they will only use the internet more and explore what it has to offer them. Therefore, they need to be educated about these issues before they start exploring social media websites and so fourth.			
		F: I agree, S1, but I still wonder if this is a late start, given some of the statistics. I almost look at it like wearing a seatbelt or a bike helmet...at first it's the parents job to strap their kid in (so, to follow the analogy, the parents job to oversee all internet interactions) and then there is the gradual release of responsibility. If they need to be educated before they start exploring, do we, educators, keep them from independently exploring until 9-12 years of age? Not sure there's an easy answer here...		
			S2: F I agree with you the parents should be the first to teach children and I think the seatbelt and Helmet example is great. My daughter had her first laptop at the age of 5, she was enrolled in a technical school so the use of technology was encouraged. By age 10 she was already working on computer animation, the schools she attended taught the students about using computer and online site carefully. I know not all students attend technology schools but how many kids do you see in doctors waiting rooms and other public places with Ipads or Iphones.	
			S3: S1 I have to agree with you. 9-12 is a good age to start this cyber ethics and at a age where it will be meaningful as well as a time where they will comprehend and take in what is being taught. I also agree with your point that as these kids will only explore and use the internet more.	
	S4: I agree with author that this is an appropriate age to begin cyber ethics instruction. Not only because students begin to use the computers a lot at this age, but they have the ability and responsibility to understand the benefits of technology and its associated vulnerabilities. However, the truth is some children play with technology at a very early age even before they go to school, therefore I think adults should be aware that their kids will be likely to be harassed by the online behaviors which will further cause some psychological damages to younger kids. Why not be preventative and tell the kids the downside of the internet at the same time so that younger kids can be more or less prepared to interact with on line world?			
		S1：I agree with you, S4. Children are playing with technology at such a young age. In fact, some children are playing with technology before they can even talk or walk. I actually watched the Today Show this morning and the news anchors were talking about how some young kids are given smart phones and are even put to bed with an iPad. I would not say it is likely that all kids will be harassed online, but parents should educate their children on the dangers of the Internet if they are going to introduce technology at a very young age.		
			F: S4 & S1--I think you are both illustrating the growing trend: children are becoming more adept with technology at a younger age, so how do we go about protecting them? I agree that it falls squarely on the shoulders of the parents, but what about when they enter school at 4 or 5 years of age? What kind of language should we be using for this very young and vulnerable group?	
				S4: I am not sure whether we should educate this young age groups very systemically, as I see they may not even be able to fully understand what cyber bullying actually means to them. However, I am thinking maybe the instruction with easily understandable

				vocabularies and assisted pictures might attract their attention, and at least let them know the dangers of Internet.	
					S5: I agree with you! I think it may get difficult to educate very young students if we do not use the appropriate vocabulary for their grade level and if we don't utilize he most effective means of grabbing and keeping their attention. I think that we can try to educate them through using visuals and motion pictures, which often appeal to kids. We also though need a balance between information giving, grabbing their attention. While these means can work we want to make sure we don't distract them as well because children's attention spans are very short.

S1 was the first student to answer this question. (S)he gave a logical explanation for her/his agreement by introducing expert opinions from the class readings and using her/his own experience of learning about cyber ethic issues. S1 created the cognitive presence of Integration in her/his response.

S1 agreed that 9-12 years old was an appropriate age. The facilitator was trying to extend S1's thoughts and asked a probing question suggesting starting the cyber ethic instruction at an earlier age. (S)he, again, cued the statistic information from the class reading, and also provided an analogy that compared the cyber ethic instruction to the "bike helmet" to show why this issue was worth our consideration. Another student S2 commented on this question. Based on the indication from the analogy of "bike helmet", S2 supported the importance of involving parents in educating kids on Internet ethics at an earlier age. And (S)he gave an explanation using the observation from her/his life. In this process, S2 created cognitive presence of Integration. (S)he built an argument based on the analogy provided by the facilitator, and also used her/his life observation to help explain her/his stands.

S1 did not directly respond to the facilitator's question, but gave her/his answer later in her/his comment to S4's post. S4, in response to the initiating question, agreed that 9-12 years old "is an appropriate age to begin cyber ethics instruction" and also pointed out that kids nowadays started to use technology at a very young age. S4 showed cognitive presence of Integration since (s)he provided a logical explanation. S1 supported S4's opinion by introducing

some evidence from an outside resource “Today Show” – young kids did use technology and some “are given smart phones and are even put to bed with an iPad”. From here S1 suggested, “parents should educate their children on the dangers of the Internet if they are going to introduce technology at a very young age” (Integration). At this point, the facilitator jumped in. (S)he firstly summarized what S1and S4’s posts had already achieved: “you are both illustrating the growing trend: children are becoming more adept with technology at a younger age.” Then the facilitator stepped further and asked probing questions to both S1 and S4: “how do we go about protecting them,” “What kind of language should we be using for this very young and vulnerable group?”. S4 came up with a possible solution of using “easily understandable vocabularies and assisted pictures (that) might attract their attention” (Integration). S5 quickly joined the brainstorming and added some ideas of “using visuals and motion pictures”. S5 proposed an important point that teachers needed to keep “a balance between information giving, (and) grabbing their attention”. (S)he explained that “While these means can work we want to make sure we don't distract them as well because children's attention spans are very short” (Integration).

Table 43: Discussion episode 3, from the treatment group

	S6: I agree with Berkowitz's conclusion that 9-12 year old are a good age to begin cyber ethics instruction. At this age, they are familiar with technology and are beginning to use it more frequently. But even more importantly, kids are old enough at this age to begin to truly grasp the implications of their Internet usage. Begin any earlier, and many students may not be developmentally able to understand; begin any later, and it may be too late.			
		S7: S6, I see where you're coming from when you say that any earlier age might not allow kids to "truly grasp the implications of their internet usage," but couldn't we argue that if we were to teach younger ages, they would not have any temptation to perform unethically? Plus, do we really think that kids under the age of 9 are too young to be developmentally able to understand responsibilities and danger?		
			F: S7--You bring up a great point about child development. It seems like education could find a way to be developmentally appropriate, much like they do with "good touch-bad touch" education and "stranger danger" education programs.	
				S7: I'm not so sure that I think the age of those being instructed on cyber ethics needs to be lowered, rather, that the instruction needs to be more common to the general public. Berkowitz states, "Only the most outrageous attacks receive significant public attention". I think this is the more important fact...that there are millions of cyber attacks occurring all the time that are simply ignored because they don't seem that crucial. However, by

				allowing the individual who are performing these attacks to get away without harsher punishment, we are only encouraging the continuance of attacks, and potentially an increase in danger. Therefore, I think that we should focus more on educating everyone on ethics and the problems that arise from attacks.		
					F: This is a great point! Frequently, we assume that only kids are uneducated, while in fact it is the general population that really needs to be consistently made aware of the dangers and pitfalls of living in a digital age.	
						S8: F, I just had a mental breakthrough as well, others besides kids should actually know about this information as well.
					S9: S7, that's a great idea! We here so many stories in the media about "hackers," and the general public should be able to differentiate when they should worry and not to. Yes, many information breaches are overlooked, but there are also many news stories that use big words only the tech-geeks know aren't anything to worry about.	
	S10: To be honest, I am not sure whether I should agree with author's opinion, but I firmly believe that each age group requires a specific approach which is more likely to work when explain Cyber ethics. For the kids of elementary schools, they are very black and white in their ethical thinking, so it is probably that teaching them how to identify the copyright symbol and tell them what kind of behavior is against the law work best for them. The middle school students ate the most challenging age groups, so I think teachers should relate scenarios to "real people" because if they could visualize victims they will think twice about the crime. For high school students, lecture-based instruction may not be effective, teachers should not only explain and talk about the legal consequences, but also let students explore the pros and cons on their own when they downloading the scenarios.					
		F: S10--That was a really thoughtful response. I think you are on target with each of the three vastly different age cohorts, and your suggestions are great places to begin thinking about instruction.				
		S11: I think you make a great point about addressing the different age groups and how you get the education to them. Children think differently in the different age groups so being able to get the information to the in ways that they understand and can make sense of the information. Great points to bring up and explain!				
			S8: S11, The earlier one could learn is only beneficial to that individual. I wish I could have known the things I know about technology now back then when I was younger.			

In the episode 2, students reached a consensus that kids younger than age of 9-12 also needed cyber ethics education. However, in episode 3 as shown in Table 43, S6 proposed a different perspective: age of 9-12 was the best age that "begin any earlier, and many students may not be developmentally able to understand; begin any later, and it may be too late" (Integration). S7 doubted this and expressed her/his disagreement by asking "couldn't we argue that if we were to teach younger ages, they would not have any temptation to perform unethically? Plus, do we really think that kids under the age of 9 are too young to be developmentally able to understand responsibilities and danger?" (Triggering event, Exploration). At this point, the facilitator emphasized S7's idea about child development. This triggered S7's further elaboration on this point. S7 proposed a new idea that age might not be the

most important issue, but “the instruction needs to be more common to the general public”. To make a solid argument about “educating everyone on ethics”, S7 also quoted the author’s statements as the evidence from the class reading – the article that the facilitator cued in the initiating question (Integration). The facilitator realized this was a promising idea and (s)he rephrased the main points in S7’s post to make this idea more visible to others. Later, S8 replied that (s)he “had a mental breakthrough” after reading S7’s post. Based on S7’s post on the issue of hacking and the cyber ethics education for general public, S8 developed the argument by adding that “the general public should be able to differentiate when they should worry and not to” (Integration).

To this point, different opinions emerged on the appropriate age for cyber ethics education, such as age of 9-12, earlier age (4-5 years old), general public, etc. S10 proposed and explained several possible solutions that may work for different age groups. The facilitator highlighted S10’s contribution by summarizing the main points. Later S11 and S8 supported S10’s idea by giving an explanation and showing agreement.

This case illustrated how student facilitators used peer facilitation techniques to sustain students’ conversation, and thus created opportunities for developing their cognitive presence. This thread was divided into two episodes (episode 2 and 3).

Looking back into the episode 2 presented in Table 42, by asking follow-up questions at the proper points, the facilitator helped the discussion to continue and supported students’ cognitive presence development. The initiating question proposed a debating issue. When students agreed that 9-12 years old was an appropriate age for cyber ethic education, the facilitator then asked students to consider the kids at an earlier age. Students then realized that kids nowadays did use digital technology at a very young age, and they also need protection and

education on cyber ethics. The facilitator further deepened the discussion by asking how to provide protection and instruction for these young kids. The facilitator also created analogy to help students understand the complex relationship between young kids, cyber safety, parents, and protection. The analogy successfully became an important building block in students' arguments. Also, the facilitator provided information from class readings and summarized students' ideas to support the discussion.

In the episode 3, a main strategy used by the facilitator was revoicing and highlighting students' contribution. This resulted in marking these ideas as important or promising. When many posts and ideas were emerging in a thread, the ideas highlighted by the facilitator might become more visible to the whole group. This would help important ideas to spread more easily in the group. It might also make the students feel that their ideas were valued and then were more likely to contribute more (such as S7).

Summary

This study explored the characteristics of students' cognitive presence and the pedagogical practices that aimed to facilitate cognitive presence development.

The content analysis revealed the distribution pattern of cognitive presence in the peer facilitated online discussion. Students demonstrated four phases: Triggering event, Exploration, Integration, and Resolution. Among the four, students' cognitive presence tended to aggregate at the middle phases: Integration and Exploration. Percentage of the Resolution was very low.

Cognitive presence was not merely an outcome but also a process of knowledge construction and understanding development. To investigate what students did in this process, the researcher examined the related discussion behaviors through content analysis and automated linguistic analysis. The distribution pattern of these discussion behaviors helped reveal: a) the

hierarchical relationship between the four phases of cognitive presence: Integration and Resolution involved a higher-level of cognitive engagement, and Triggering event and Exploration involved a lower-level of cognitive engagement; b) the phase of Resolution heavily relied on experiment, while the other three phases heavily relied on making use of personal experience; c) the creating of cognitive presence occurred in both the private space of individual activities and the shared space of having dialogues.

To study the peer facilitation of cognitive presence, the researcher designed and implemented two interventions: 1) Intervention 1: providing guidance on peer facilitation techniques; 2) Intervention 2: asking students to label their cognitive presence. Experiments were conducted to determine the effects of Intervention 1, Intervention 2, and the combination of two interventions. The results showed that the Intervention 1 and the combination of two interventions credibly improved students' cognitive presence. They were especially effective in improving Integration, a higher level of cognitive presence. After having added Intervention 2, the effects of the interventions became larger. Cognitive presence increased from the first-half to the second-half semester, although the improvement was not found to be statistically credible.

Guided by the Community of Inquiry framework, the researcher also examined the dimensions of social and teaching presence that could elicit cognitive presence. The results showed that the pedagogical interventions were effective in improving students' social interactions and their peer facilitation behaviors. The results also confirmed the close associations between social interactions, peer facilitation, and cognitive presence. The positive correlation between the use of peer facilitation techniques and the frequency of students' cognitive presence suggested the effectiveness of these facilitation techniques and the intervention of providing guidance on peer facilitation. It was also interesting to find the

association between student facilitators' use of peer facilitation techniques in the facilitation week and their cognitive presence showed in the whole semester.

The conversation analysis of concrete discussion threads and episodes demonstrated the temporal evolvement of cognitive presence and the dynamic process of how peer facilitation supported the creating and developing of cognitive presence. The cases showed that students' cognitive presence evolved in a non-linear way, rather than strictly phase by phase as suggested by the PI model. The cases also revealed that when student facilitators were provided with the guidance on peer facilitation techniques, they used a variety of facilitation techniques strategically to help students achieve a sustained and deeper-level conversation. Compared to the control group, the facilitators in the treatment group showed more peer facilitation behaviors, which led to more conversations among peers and more higher-level cognitive presence created by students.

CHAPTER 5

CONCLUSIONS & IMPLICATIONS

Chapter Overview

This chapter discussed the main findings on the research questions presented in the Chapter 3, as well as the important implications for online instruction and discussion analytics.

Addressing the Research Questions

This section discussed the main findings on the research questions that this dissertation intended to answer.

Question 1: What are the characteristics and patterns of students' cognitive presence in peer-facilitated AOD?

Content analysis of students' discussion transcripts revealed that students demonstrated four phases of cognitive presence in their discussion inquiry: Triggering event, Exploration, Integration, and Resolution. Among the four phases, students' cognitive presence tended to aggregate at the middle phases: Integration and Exploration. The pattern of cognitive presence, to some extent, revealed the learning experience that the peer-facilitated discussion created for students. When responsibility was shared with students, they showed active and deep learning. Students not only were able to explore, create, and exchange ideas and information, but also, they were able to integrate information pieces, build upon peers' contributions, and develop robust arguments. The distribution pattern showed the very low percentage for the phase of Resolution. It was very likely that this was related with the requirements of the discussion activity in which students were not asked to implement their ideas. In order to help students to have a full cycle of inquiry in online discussion, instructors/facilitators could provide more guidance or support to help students reach the phase of Resolution. For example,

instructors/facilitators could give more prompts to ask students to use their field experience to evaluate the discussed ideas or make it explicit in the learning objective to ask students to apply their ideas.

The analysis of the related discussion behaviors examined what students did in creating and developing cognitive presence. At different phases of cognitive presence, students showed distinct distribution patterns of engagement mode, constructive use of resources, idea collaboration, and use of linguistic features and words. The identified patterns revealed important information about the characteristics of cognitive presence. For example, a) there is a hierarchical relationship between the four phases: Integration and Resolution involved a higher level of cognitive engagement, and Triggering event and Exploration represented a lower level of cognitive engagement. b) Students' past experience and life observation was an important resource for them to create cognitive presence in online discussion. c) While the first three phases heavily relied on personal past experience, the phase of Resolution heavily relied on experiment. This implied that, to help students to arrive at the phase of Resolution, more opportunities of experimenting with the discussed ideas could be provided to them. d) Students tended to create their cognitive presence in both the private space of individual activities and the shared space of having dialogues. e) The automated linguistic analysis revealed that each phase of cognitive presence had distinct distribution of a certain categories of words and linguistic features with psychological meanings. These identified linguistic feature helped reveal students' cognitive and emotional state at different phase of cognitive presence. Additionally, it could lay a foundation for developing tools that can automatically analyze students' cognitive presence in online discussion.

The conversation analysis of discussion threads and episodes demonstrated the temporal evolvement of cognitive presence. The results showed that, in online discussion, students did not develop their cognitive presence linearly and sequentially as suggested by the PI model. But rather, any phases could emerge at any time, and the sequence of phases kept changing with the discussion flow. The developing of cognitive presence was, in fact, a process of change involving non-linear and abrupt phase transitions. Another interesting finding was that students tended to create their cognitive presence in a collective manner at the earlier time of a week. At the later time of the week, less discourse took place; and students were more likely to create their cognitive presence individually.

Question 2: Whether and how providing guidance on peer facilitation techniques affects students' cognitive presence? What are the effective facilitation techniques that promote cognitive presence?

To determine the effects of providing guidance on the peer facilitation techniques (Intervention 1), statistical analysis was conducted based on the outcome of content analysis. Considering the characteristics of the data and the multiple comparisons this study needed to make, a Bayesian approach was used. The results showed that the guidance on peer facilitation was effective in improving students' cognitive presence in online discussion, especially effective in promoting Integration, the higher level of cognitive presence.

The effects of the intervention on cognitive presence of Resolution was very small. The occurrence of Resolution was so sparse that the statistical analysis could hardly detect the relationship between Resolution and other variables of interest. This also led to another important issue that why the intervention did not significantly improve students' cognitive presence of Resolution in online discussion. As discussed before, this might be related with the

course reality: students were not expected/required to apply their discussion ideas; they might not have field resources to test their ideas; each week, the time left for idea implementation was limited; and in the discussion activity, they did not received enough support and guidance that helped them to reach the phase of Resolution.

Content analysis of discussion was conducted to analyze the use of peer facilitation techniques by student facilitators. The results revealed that students showed more peer facilitation behaviors when they were provided with the guidance on peer facilitation. The six types of peer facilitation techniques – asking question, making clarification, promoting connection, synthesizing & revoicing, providing information, and using positive social cues were all positively correlated with cognitive presence of Triggering event, Exploration, and Integration. These correlations were statistically credible. The finding was consistent with the student survey showing that student self-rated cognitive presence was positively related with their perception on the peer facilitation they received in online discussion. Another interesting finding was the close association between students' involvement in peer facilitation during the facilitation week and their overall performance in creating cognitive presence for the whole semester. The peer facilitation produced reciprocal benefits. Students received pedagogical facilitation from student facilitators in an on-going discussion. While at the same time, student facilitators also benefited from this process since the role pushed them to have awareness of the discussion progress and be actively engaged in conversation by using a variety of discussion strategies. This experience was very likely to help student facilitators to develop their metacognitive awareness of their own learning and the habit of strategically participating in the discussion to achieve a higher level of intellectual engagement.

Several effective facilitation techniques were obtained through analyzing the concrete peer facilitation behaviors and examining how the peer facilitation techniques helped discussion proceed. Effective techniques included: asking explanatory questions, giving logical explanation, giving real-life examples to help clarify, cueing class readings, revoicing important ideas, reflecting on discussion progress, introducing facts from personal experience, introducing expert resources, presenting alternative/new perspectives, showing agreement or shared understanding, and giving compliment. All these techniques were found to be closely associated with students' cognitive presence. Conversation analysis of discussion threads and episodes demonstrated the dynamic process of how students used these techniques to help peers to create and develop cognitive presence. The results showed that when student facilitators were provided with the guidance on peer facilitation techniques, they tended to use a variety of facilitation techniques in a strategic way to help students achieve a sustained and deeper-level conversation. Compared to the control group, the facilitators in the treatment group showed more peer facilitation behaviors, which led to more conversations among peers and more higher-level cognitive presence created by students.

Social network analysis showed that providing guidance on peer facilitation also improved students' social interaction. When students were guided on peer facilitation techniques, they had more social interactions with peers, and they became more active in the group discussion. The student survey provided consistent evidence of the positive correlation between students' self-rated social interaction and the peer facilitation they had received. More importantly, students in the treatment group showed more higher-level social interactions in which they demonstrated constructive behaviors of collective reasoning and building on peers' ideas – the behaviors that featured the Integration phase of cognitive presence.

It was highly possible that, by improving social interaction, the peer facilitation indirectly improved students' cognitive presence. The content analysis of idea collaboration provided strong evidence of the association between social interaction and the behaviors of idea collaboration. Interacting on the idea level created opportunity of developing cognitive presence. Close association was found between the number of social interaction and the occurrence of cognitive presence.

Question 3: Whether the metacognitive practice affects students' cognitive presence in peer-facilitated AOD?

Content analysis was conducted to examine the effects of the metacognitive practice – asking students to label their cognitive presence (Intervention 2). This intervention was implemented in the second half semester. The addition of this intervention helped students to develop more cognitive presence, though the improvement was not found to be statistically credible. An interesting finding was that the combination of Intervention 1 and Intervention 2 had a stronger effect on students' cognitive presence than merely using a single intervention.

Asking students to label their cognitive presence also improved student' social interaction. Social network analysis revealed that, when Intervention 2 was implemented, students' social interaction increased from the first half to the second half semester. Compared to the students in the control group who became less active in online discussion from the first half to the second half semester, students in the treatment group became more active. The combination of Intervention 1 and Intervention 2 had a much stronger effect on students' social interaction than merely using one single intervention.

This study did not find any credible impact of Intervention 2 (asking students to label their cognitive presence) on students' peer facilitation behaviors. This might be due to the fact

that, during the facilitation week, student facilitators were not asked to label their cognitive presence.

Limitations

This study has several limitations.

Firstly, the analysis of cognitive presence was based on examining students' discussion behaviors with limited reference to the subject content and discussion topics. The conversation analysis in this study analyzed the process of creating cognitive presence by looking at the topic development in threads and episodes. However, the discussion content and topics only served as a context of how cognitive presence developed. How cognitive presence was linked to discussion content were not explored. In fact, the cognitive challenges of inquiry in online discussion are likely to vary depending upon the type of subject content being explored. For example, whether the content is theory oriented or practice oriented, whether the content closely relate with students' prior knowledge or current concerns, whether the content being explored is essentially factual, procedural, categorical, or more deeply conceptual. The next step of this study will use the text mining techniques of topic modeling to explore: in the process of developing cognitive presence, what common themes will emerge in discussion; how cognitive presence is associated with the type of discussion topics and the topic relevance; and the possible relationship between cognitive presence and topic complexity.

Secondly, this study was a short-term study with a small sample size. The researcher investigated the intervention of providing guidance on peer facilitation over one semester and the intervention of asking students to label their posts over half a semester. Some key conceptual and attitude change might take place over prolonged periods. Examining the interventions over a longer term would enable the researcher to document these changes and to track their cognitive

development. In addition, the sample size is small. Thus, a follow-up study could be conducted to implement the interventions over three or more years in a larger online class and to track the online discussion performance of the same cohort of students. Then the researcher can collect more student achievement data to help assess the effects of the interventions.

Thirdly, the effects of the Intervention 2 might be affected by a few factors. Two interventions were implemented in this study: Intervention 1 (providing guidance on peer facilitation techniques) was implemented from the beginning and lasted for a semester; and Intervention 2 (asking students to label their posts) was added in the middle of the semester and lasted for half a semester. The combination use of two interventions in the second semester brought in challenges in analyzing the effects from Intervention 2. It was possible that the impact of the Intervention 2 on students' cognitive presence would be affected by the implementation of Intervention 1. In addition, since the student facilitators were not asked to label their cognitive presence during their facilitation, it was also hard to find out the association between the Intervention 2 and students' peer facilitation behaviors. In the future study, the two interventions could be implemented separately to examine the effects of each intervention. To investigate the effects of the Intervention 2 on students' facilitation behaviors, student facilitators could also be asked to label their posts.

Implications

Findings from this study have important implications for research and practice in online instruction and discussion analytics.

Implications for online education

Sharing leadership and responsibility with students is an important strategy to create a productive learning community in an online course. Sharing leadership with students can create

instructional opportunities to enhance students' learning. As shown in this study, when responsibility is shared with students, they engage in active and deep learning by creating cognitive presence of Exploration and Integration. When given the opportunity for peer facilitation, students strategically use a variety of peer facilitation techniques to support peers' understanding advancement and dialogue development. While at the same time, student facilitators themselves also achieve high intellectual involvement by actively playing the facilitating role and deeply diving to different peers' perspectives. Student autonomy could be created in this process. This is important especially when class size is large, such as the MOOC classes. In this case, it is not realistic for an instructor to support the participation of thousands of students. Student facilitation could be a pedagogical practice that has the potential to transform students into independent, autonomous, and self-motivated members of an auto-facilitated learning community.

Providing students with guidance and support on peer facilitation is helpful. Since not all the students have prior knowledge and experience of online teaching/learning, they may not spontaneously know how to support peers' learning effectively. Though peer facilitation has the pedagogical potential, online instructors cannot expect students to assume full responsibility for their online learning. They need research-grounded, continuous, and just-in-time support to help them fulfill the facilitation tasks. Our findings suggest a need for training students on the use of peer facilitation techniques that are grounded upon theory and validated by empirical research. Results from this study show that the guidance on these peer facilitation techniques is effective in improving all the elements that are outlined by the Community of Inquiry framework: cognitive presence, social interactions (social presence), and peer facilitation behaviors (teaching presence).

Merely giving students the guidance on peer facilitation is not enough. There are a number of important issues we need to pay attention to: a) To help students understand the meaning of each type of facilitation techniques, it would be helpful to provide concrete examples from the scenarios students feel familiar with. b) It is also of great importance to allow flexibility and freedom in the guidance. Since students are adult learners who have developed their own philosophy and value system, the guidance can not become a script that prescribes every move student facilitator should take in facilitating the discussion. But rather, the guidance is a tool that helps students to become aware of the ingredients of effective peer facilitation. Students should have the freedom to develop their own recipe of facilitation based upon their philosophy for teaching and life. It is also important that they can have the flexibility to make the decisions that are responsive to the emergent events in an ongoing discussion. c) It is necessary to give continuous support to student facilitators to make sure that they understand and implement the facilitation techniques in an appropriate way.

Guidance and support is needed to ensure that students have a full cycle of inquiry in online discussion. The results in this study show that, compared to the first three phases of cognitive presence, the occurrence of Resolution is very low. Eliciting more cognitive presence of this phase is important to help students to complete a full cycle of inquiry and engage in deep and meaningful learning (Garrison & Anderson, 2003). To achieve this goal, instructors/facilitators could include the task of idea implementation in the assignment of discussion. This would convey a message to students that showing cognitive presence of Resolution was expected of them. Instructors/facilitators could also create opportunities for idea experimenting by prompting students to evaluate ideas using their field experience or

observations or even providing them with clinical practice opportunities in which students could have a chance to observe/practice how their ideas could be realized in real life.

Online instructors need to look at learning as a dynamic learning process, rather than to merely measure the static final learning outcomes, for assessing the quality of students' online learning. The conversation analysis in this study indicates that the process of developing cognitive presence is a sequence of emergent learning events in an evolving dialogue. This dynamic process reveals rich information of how understanding develops, how misunderstanding and cognitive conflicts occur, how students orient to what is happening in the discussion, and how the learning and facilitation events are sequentially ordered. In fact, phases of cognitive presence not only are the cognitive outcomes students achieved in their discussion, but also are the ways students go through to move the dialogue forward. If this process is ignored, the instructor might miss important information on tracing critical transformations in students' understandings. When the instructors have a clear understanding of all this information, they are more likely to assess students' learning in a responsive and reflective manner.

Implications for discussion analytics

Use multiple analytic methods or tools to study cognitive presence. The Practical Inquiry model, which defines the phases of cognitive presence, is inclusive to various forms of thinking as the inquiry process requires the integration of multiple cognitive processes (Garrison & Archer, 2000). It is important to use multiple tools to measure the different dimensions of students' cognitive presence. In exploring the characteristics of cognitive presence, this study examines students' discussion behaviors such as engagement mode, constructive use of resources, idea collaboration, and use of linguistic features and words. The results suggest that these behaviors are helpful in revealing what students actually do in each phase of cognitive

presence and how social interaction and cognitive presence are linked together. In addition, the Community of Inquiry framework assumes that learning occurs in the synergy of all three factors – cognitive presence, social presence, and teaching presence. The results from this study reveal the close association between and among the three. Therefore, the study of cognitive presence should be situated in the context of both social and teaching presence. Since various dimensions and factors are taken into consideration, there is a need for multiple analytic methods to investigate the complexity of cognitive presence.

More research is needed on the automated analytic tools for analyzing and visualizing the dynamic process of students' discussion and learning. In this study, the researcher used conversation analysis of two discussion cases to show the dynamic process of developing cognitive presence. However, the ability of manually analyzing the conversation is limited in classes that have large student enrollment. More research is needed to develop methods and tools that can help online instructors to quickly know the status of students' cognitive presence, how their dialogues move, how they interact with peers, and how their understandings change. The results from this study may also help develop this kind of tool. For example, the automated linguistic analysis identified the linguistic features that characterize the different phase of cognitive presence. These linguistic features can serve as factors that can be used to predict students' cognitive presence automatically.

APPENDIX A

Instructions for Peer Facilitation

As the facilitator, your role includes two tasks:

Task I: Asking and posting questions to initiate the discussions by Sunday midnight of the week

To ask good initiating questions, please make sure to follow these steps:

1. Finish this week's reading first (the week when you are facilitator). Weekly materials are available on Blackboard Thursday night before your designated week.
2. Then prepare at least 3 questions in advance of class, including:
   - ✓ TWO questions based on readings
   - ✓ ONE question about the technology project (For example, you can ask students to communicate their project findings and conclusions they've got so far, discuss the key issues they've encountered in their project, or reflect on their project experience).
3. Before posting the questions to Blackboard, please sent them to TA (Ye Chen, ychen129@syr.edu) first to get the approval. If you have any questions, please contact Ye.

Good questions are the key to a productive discussion. Based on course readings, try to identify authentic and real life issues. This is a strategy that gets people involved in telling their own experiences as they relate to the discussion topic. A discussion should then begin that flows naturally and freely.

We recommend you to ask explanatory open-ended initiating questions to open up each week's discussion. An open-ended question is one which cannot be answered by a "yes" or "no" and seek explanation, inference, and speculation. This kind of explanatory questions (such as *why, how, what-if*) have more potential to trigger higher level of integrated thinking as idea connection, justification, and application.

Task II: Facilitating the discussions during the week

1. Please carefully read the guide below on how to facilitate online discussion. If you have any questions or concerns about the use of strategies, please feel free to email: Ye Chen (ychen129@syr.edu)
2. Please log in Blackboard forum daily, read students' posts, and respond to them using facilitating strategies. You don't have to use all the strategies in this guide, just choose the ones you feel appropriate and useful.

3. A checklist of facilitating strategies is provided. You are expected to use it to record your strategy use. Please send back the checklist to TA (ychen129@syr.edu) at the end of the discussion week (by Sunday Midnight). During the facilitating week, you need to keep aware of the strategies you are using, but do not have to tag your posts.

Guide on Facilitating Strategies

Overview of facilitating strategies

(For detailed explanation and examples, please see **Strategies for Facilitating Discussions)**

Strategies	
Ask question	• Ask authentic and real life questions • Ask explanatory question • Check joint understanding
Make clarification	• Prompt for self-explanation/Give explanations • Give examples • Create analogies • Using diagrams to communicate ideas
Promote connections	• Cue students' prior knowledge or personal experience • Cue reading materials • Cue class projects • Cue previous discussion messages
Synthesis and summary	• Synthesize available ideas • Revoicing-highlight the important idea(s) • Reflect on the discussion progress
Provide information	• Introducing facts from experience • Introducing facts from authoritative sources • Present alternate perspectives • Identify problems • Give personal opinions
Use positive social clues	• Show empathy/shared understanding • Show agreement • Praise • Show thanks • Invite open discussion

Strategies for Facilitating Discussions

1. Ask Questions

- ✓ Ask authentic and real life questions
- ✓ Ask explanatory open-ended question
- ✓ Check joint understanding

Besides the initiating questions, you are also encouraged to ask follow-up questions to probe for deeper analysis, ask for clarification, examples or evidence, or explore implications. Leading a great discussion requires that we actually interact with one another's ideas—not just speak at each other. To help students do that, you can ask follow-up questions that let the sharer know he or she was heard, clarify what has been said, check the shared understanding, and invite other group members to interact with what's been shared.

Here are some examples of asking follow up questions:

- Would you like to explain more about reasons behind this relationship?
- Could you explain what you are thinking?
- Could you explain the concept of the idea discussed in your posting?
- Could you explain what you mean by…?
- What is your thinking on that?
- What were you thinking about when you say…?
- How did you come to hold that point of view
- Any more you want to say about this?
- So, specifically, what else does this tell us?
- Could you think of an example of…?
- How does it work?
- How does it do that?
- Then, what happens next if …?
- What is it related to?
- How does it relate to what you've already seen?
- What is the justification for this? Why is it correct?
- What law, definition, or rule allows one to draw that conclusion?

2. Make Clarification

- ✓ Prompt for self-explanation/Give explanations
- ✓ Give examples
- ✓ Create analogies
- ✓ Using diagrams to communicate ideas

To balance your use of open-ended questions, clarifying is a facilitating technique you can use to make a point clear. To do this, you can use the prompts listed in section *I: Ask Question* to elicit sharer's self-explanation, or you can give your own explanation (but in most occasions, we suggest you to encourage sharer to give his/her explanation).

You can also use some concrete examples from your teaching experience or observation to instantiate your idea.

Or, you can create some analogies to make your point easily understood. Here are some analogy examples from previous students:

- Presenting yourself in social network is like having an elevator conversation. Imagine that…
- …it is not fair to say that technology is good or bad, …, they are trucks, users are drivers …
- …web 2.0 is like a gravitational core. … web 2.0 is continually growing and changing. First came web 1.0, then 2.0 grew from it and has been opening up new opportunities for the world.

To convey relationships that are difficult to put into words, you can use graph or drawing to help explain.

3. Promote connections

✓ Cue students' prior knowledge or personal experience
✓ Cue reading materials
✓ Cue class projects
✓ Cue previous discussion messages

Learning is about making connections. In the process of discussion, the more integrated mental scheme students developed, the more retrieval cues are formed to make learning more durable and stable (King, 1994). As a facilitator, try to establish links with weekly readings, technology project, or students' personal experiences, etc. Revisit past contributions in forum and incorporate them into subsequent discussions. Encourage student to add their reactions to build on someone's idea.

Here are some examples from previous students:

- Think of a class you have taught or would like to teach…
- ...in one of the articles there was much talk of there being a fine line that..
- Based on this week's readings…
- As we discussed in earlier weeks it is important to …

4. Synthesize and summarize

✓ Synthesize available ideas
✓ Revoicing-highlight the important idea(s)

✓ Reflect on the discussion progress

As much as possible, bring ideas together, highlight certain discussion, or repeat important information. Monitor and reflect on discussion progress. If time permits, encourage students to share what they learned or discovered during the discussion. By synthesizing the ideas, the group can see that their input and shared experiences helped everyone to learn something (it might be also valuable for them to realize that they even helped you, the facilitator, learn something new!).

5. Provide information

✓ Introducing facts from experience
✓ Introducing facts from authoritative sources
✓ Present alternate perspectives
✓ Identify problems
✓ Give personal opinions

To support the discussion, you can make use of your experience in local practice, or reference authoritative sources from books, internet and other avenues. Or you can identify some problems that worth investigating. As a member of this discussion community, you can also make your contribution by sharing your opinions or presenting alternate perspectives.

6. Use positive social clues

✓ Show empathy/shared understanding
✓ Show agreement
✓ Praise
✓ Show thanks
✓ Invite open discussion

Effective learning and comfortable communication is most likely to occur when there is an open and friendly atmosphere. If you set up a friendly atmosphere from the beginning, it will encourage participants to talk rather than just answering a series of questions.

Respect one another's views. You can express your shared feeling (e.g. I know what it feels like to teach in a place where technology is not available), agreement (e.g. I agree…; you are correct…), compliment (e.g.You raised a very good question), and thanks (e.g. Thank you for bringing up a critical point here) when you respond to them. When you respond to someone's posting, you can also make it clear that open discussion is invited.

Here is an example from previous students:

- I asked a few questions in relation to **'s post, but open all of my questions up to the entire group, so feel free to answer other questions as they come up, and please ask any questions of the group as well.

Of course, you can accept and respect someone's feelings without necessarily agreeing with their point of view. When someone's input includes incorrect information, you can make a statement that stresses the value of their experience and your respect for their decision, whether you agree with it or not. Some possible response examples which avoid embarrassing the person are:

- I'm very glad that worked for you. Other people have found that … worked better for them.
- I'm glad you brought that up. That "used" to be what was generally recommended, but now new research has found that…
- You've brought up a really interesting issue. Let's look it up in (a specific reference) and see what they say about it.
- That's interesting. What could you have done differently if you had the information we have talked about in our discussion?

Facilitating Checklist

This checklist is for self-check. Please put an X mark in **[ ]** if you have used the corresponding strategy in this week's discussion, and send back this checklist to TA (ychen129@syr.edu) by Sunday midnight.

Strategies		
Ask question	Ask authentic and real life questions	[ ]
	Ask explanatory question	[ ]
	Check joint understanding	[ ]
Make clarification	Prompt for self-explanation/Give explanations	[ ]
	Give examples	[ ]
	Create analogies	[ ]
	Using diagrams to communicate ideas	[ ]
Promote connections	Cue students' prior knowledge or personal experience	[ ]
	Cue reading materials	[ ]
	Cue class projects	[ ]
	Cue previous discussion messages	[ ]
Synthesis and summary	Synthesize available ideas	[ ]
	Revoicing-highlight the important idea(s)	[ ]
	Reflect on the discussion progress	[ ]
Provide information	Introducing facts from experience	[ ]
	Introducing facts from authoritative sources	[ ]
	Present alternate perspectives	[ ]
	Identify key issues or problems	[ ]
	Give personal opinions	[ ]

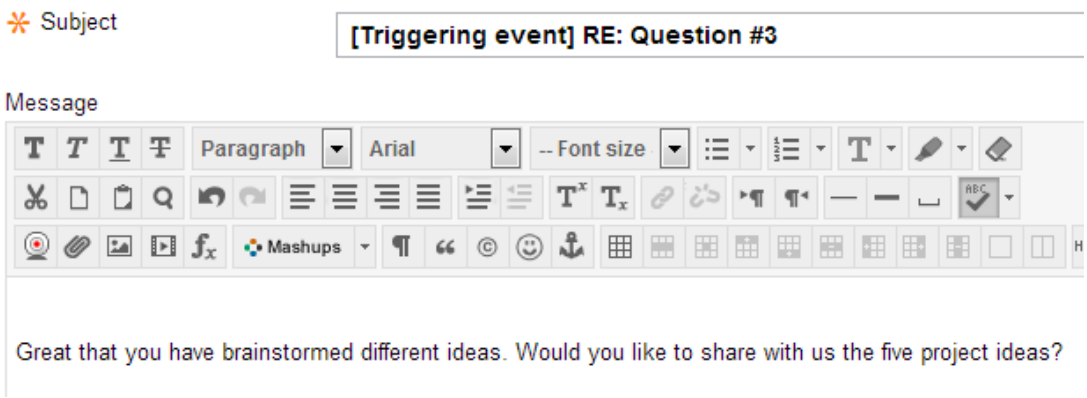
Use positive social clues	Show empathy/shared understanding	
	Show agreement	[ ]
	Praise	
	Show thanks	
	Invite open discussion	

Any other facilitating strategies I've used and found useful but not listed above?

APPENDIX B

Instruction on Labeling Post

1. Please carefully read attached introductions of cognitive presence.
2. After having written your posting, think about what category/categories your posting could fall in. There are four categories: Triggering Event, Exploration, Integration, and Resolution (See explanation of each category in Section II-V)
3. In the title place-Subject box (see below), add a tag to specify which cognitive presence category this posting belongs to. If you consider your post has multple categories, then please type all of them. For example, if there are both Triggering Event and Exploration in your posting, then type: [Triggering event, Exploration].
4. You will tag the posting by using the four categories before you submitting it. There is no absolute right or wrong for your tagging. Tagging is an opportunity for you to reflect on your discussion.



I. What is Cognitive Presence?

Cognitive presence is the evidence of cognitive engagement in learning and inquiry. Garrison et al. (2001) defined cognitive presence as "the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse" (p. 11). This concept is operationalized through Practical Inquiry (PI) model (See Fig. 1), which has identified four categories of cognitive presence: 1) **Triggering event** initiates critical inquiries; 2) **Exploration** collects divergent ideas and recourses; 3) **Integration** pieces together different ideas by connecting, comparing, evaluating, and synthesizing; 4) **Resolution** applies and tests ideas in real world.

Students' metacognitive awareness of their inquiry states is important in enhancing their learning performance in online discussion (Garrison, 2007). One suggestion to raise students' awareness is to ask students to self-code their responses, and this has been approved to be effective in empirical studies (e.g. Leng, et al., 2009; Pawan et al., 2003; Muukkonen et al., 2005).

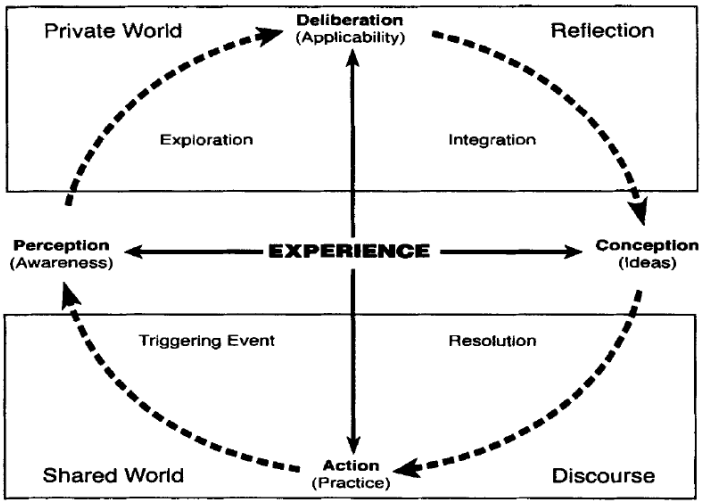


Figure 1: Practical Inquiry Model (Garrison et al., 2000)

II. Triggering event

Description:
– In a "Triggering event" post, you may introduce experiences related to educational technology integration which you find confusing and difficult to understand, or you feel interested in or curious about. Your contribution is intended as an appeal to the other group members to help you clarify and understand your problem.
– You may also use your posting to follow-up on a problem that has already been discussed but raised new specific issues that you would like to elucidate. In this way your posting can be the starting point for deepening and refining knowledge obtained in an earlier discussion cycle.

Checklist (Please check if your posting fits any one of following descriptions):
– Are you asking questions on issues that are salient to you and that you would like to examine in-depth?
– Are you trying to describe the matter that is puzzling you?
– Are you gradually moving to a problem definition?

Examples from previous students:
In the article titled, "Safety and Social Networking" there are many "social networks worth exploring". After you review them, identify 2 that you think would be the best to use in an educational setting. ***Why? What might they offer teachers and students?*** *Please feel free to venture outside of the article listed above to find social networking sites that might be beneficial for educators to use with students* [Ask questions]

In past online classes (where I was not able to meet face-to-face with the instructor) I have tried to email a question or post a question on a discussion board and I will hear nothing back from the instructor, or their response will be so delayed that it does not mean anything or help anymore. It can be quite frustrating for a student that is having trouble to not be able to contact their instructor. Does anyone have thoughts on how this can be prevented? … does anyone know of maybe an app that can be used to notify the teacher when there are questions waiting for them…? [Describe a problematic scenario]

How do its functions compare to something like Blackboard?; is there a place to build a classroom social network that is also private?) [Ask follow-up questions]

III. Exploration

Description:
In an "Exploration" post, you may **share** articles, websites, or any sources of information to explore the problem. You may also give **new ideas** about the problem. The aim of an "Exploration" post is to brainstorm ideas and clarify the problem by collecting divergent resources and different perspectives. New ideas are often generated in this process.

Checklist (Please check if your posting fits any one of following descriptions):
– Do you share information or resources to help analyze the problem and map it out clearly?
– Are you using your current knowledge to come up with as many explanations of the problem as possible?
– Are you trying to express your thoughts (interpretations, hypotheses, and theories) as clearly as possible so that the others can understand them?

Examples from previous students:
Here is a link that tells more about dysgraphia than I can here... [Share information/resource]

the only downside is the fact that your idea is now public. I've had a few problems where people have ripped off my ideas and even some of my documents. [Give an opinion]

One reason I think it is seldom used it that it is too complicated to get cooperation. Another may be the mind-sets of those in charge to change practices. [Generate new ideas]

Edmodo is helpful:
-It is free
-provides teachers with a way to set up classes, assignments, and places to submit assignments as well.
-It has a look that is similar to Facebook so many students often take a liking to it.
-It even has the ability for teachers and students to communicate with one another
- I know teachers that use it religiously and swear by it. They say it has made a huge difference in their teaching.
[Generate new ideas/explanations as many as possible]

IV. Integration

Description:

– In an "Integration" post, you may respond critically to others' posts. You express you own arguments against or in favor of the ideas put forward and you indicate how useful you think the proposed ideas are for resolving or explaining the problem. You **justified your stands** by giving reasons or evidences.
-You may **synthesize** the ideas, try to identify **connections** between different ideas and describe which aspects are overlapping, complementary, or contradictory.

Checklist (Please check if your posting fits any one of following descriptions):
– Are you justifying a statement? Are you using your currently available knowledge to think logically about the explanations suggested?
-Are you building on others' ideas? Are you trying to generate justified arguments in favor or against explanations suggested by others?
– Are you integrating the ideas emerged in previous discussions? Are you looking for connections between ideas?
– Are you trying to ascertain the relevance of the suggested ideas for resolving or explaining the problem under discussion? Or, do you make suggestions for ideas, theories, or solutions on which the group should be concentrating?

Examples from previous students:
I think that investing in technology in schools is important and a must. … ***Through research and personal experience****, I have found that students are more engaged in the content if they are virtually learning it or are experiencing it through some kind of technology.* ***This is true because*** *students are immersed in technology all day, so incorporating it in their learning will benefit them because it is creating a bridge between their daily lives and school.* ***As this week's reading stated****, technology can be used for multiple purposes within learning environments. It is a media for inquiry, communication, construction, and expression.* ***Therefore****, technology creates multiple opportunities for students to use the skills that they have to help them learn the educational content*.
[Logically develop an explanation, integrate ideas/resources]

I think you make a good point…. With regards to the first point, I can see why schools would want to entice students to come to their school. … [Build on others' ideas]

V. Resolution

Description:
– In a "Resolution" post, you may test or defend explanations suggested in previous discussions by introducing information from your own experience or observation in real world.

– You may apply the ideas to real world, and test or experiment them in the real practices.

Checklist (Please check if your posting fits any one of following descriptions):
– Are you searching for empirical evidences from your experience or observation to defend your ideas/solutions? Are you trying to explain the evidence as concretely as possible to the other group members?
– Are you applying newly gained insights/ideas to the real problem? Does this lead to resolutions, predictions, or conclusions?

Example from previous students:
*… Schoology (www.schoology.com) that **I use with all of my classes**. ... It has really helped me to manage my classroom business much more efficiently and I really think the students like the ability to access the materials at all times… Schoology is a pre-form site that fits really easily in to classes without a lot of wasted time on decorating. **This week, in fact, I** asked my seniors to read a few articles about personal statement/college essays and then carry on a discussion on Schoology about the readings. Since they already had this discussion in their head before coming to class, the scaffolding was much less complex and we could jump right into the good stuff. The site also offers an "albums" tools that I opened to students to post class candidates to. Of course, I edit this just in case, but it is a really nice way to create a warm classroom community without a lot of set up hours on my part. The best part is that the only students with a predetermined access code can gain access to the course site, so it is very safe.*

APPENDIX C

Student Survey

You will use the following questionnaire to reflect on your experience in online discussions in this course. There are five sections in this questionnaire. Completing the activities will take 15 minutes. This activity will help you reflect on your learning experience, and help us better understand how you learn through online dialogue, and design instructional activities to accommodate your learning needs. We also hope you enjoy the experience of using the online survey tool Qualtrics. Your answers in this survey will not influence your course grade. 4 bonus points will be given to your final grade/score once you participate.

Section 1: Demographic Information

1. How many years of Teaching/Training/Coaching Experience do you have?

None

1 to 3 years

4 to 5 years

6 to 10 years

11 to 20 year

More than 20 years

2. Do you have any tutoring experience?

Yes

No

Section 2: Social dimension. Please indicate on a scale of 1 to 5, your responses to each of these statements. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

3. Getting to know other course participants gave me a sense of belonging in the course.

4. I was able to form distinct impressions of some course participants.

5. Online or web-based communication is an excellent medium for social interaction.

6. I felt comfortable conversing through the online medium.

7. I felt comfortable participating in the course discussions.

8. I felt comfortable interacting with other course participants.

9. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.

10. I felt that my point of view was acknowledged by other course participants.

11. Online discussions help me to develop a sense of collaboration.

Section 3: How did you engage in discussion? (cognitive presence) Please indicate on a scale of 1 to 5, your responses to each of these statements. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

12. Weekly discussion questions posed increased my interest in course issues.

13. Online course activities piqued my curiosity.

14. I felt motivated to explore content related questions.

15. I utilized a variety of information sources to explore problems posed in this course.

16. Brainstorming and finding relevant information helped me resolve content related questions.

17. Online discussions were valuable in helping me appreciate different perspectives.

18. Combining new information helped me answer questions raised in course activities.

19. Learning activities helped me construct explanations/solutions.

20. Reflection on course content and discussions helped me understand fundamental concepts in this class.

21. I can describe ways to test and apply the knowledge created in this course.

22. I have developed solutions to course problems that can be applied in practice.

23. I can apply the knowledge created in this course to my work or other non-class related activities.

Section 4: Facilitation (Note: Please base your answer on the overall performance of the facilitators this semester) Please indicate on a scale of 1 to 5, your responses to each of these statements. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

24. Weekly student facilitators were helpful in guiding the class towards understanding course topics in a way that helped me clarify my thinking.

25. The student facilitators helped to keep course participants engaged and participating in productive dialogue.

26. The student facilitators helped keep the course participants on task in a way that helped me to learn.

27. The student facilitators encouraged course participants to explore new concepts in this course.

28. The student facilitators were helpful in identifying areas of agreement and disagreement on course topics that helped me to learn.

29. The actions of student facilitators reinforced the development of a sense of community among course participants.

30. The student facilitators helped to focus discussion on relevant issues in a way that helped me to learn.

31. The student facilitators provided feedback that helped me understand my strengths and weaknesses.

32. The student facilitators provided feedback in a timely fashion.

Section 5: Instructions and training on facilitating discussion and tagging cognitive presence. Please indicate on a scale of 1 to 5, your responses to each of these statements. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

33. The instruction and training of facilitating discussion was helpful

34. The suggested facilitating strategies were effective in facilitating class's discussion

35. Tagging instruction helped me become/stay aware of my cognitive presence in online discussion

36. Awareness of my cognitive presence (trigger event, exploration, integration, resolution) helped my learn better through class dialogue

37. After having been trained on tagging, I felt that I showed more higher-level cognitive presence (integration, resolution).

You first and last name. You can skip this question if you do not feel comfortable. You can inform TA of your participation through email (Ye Chen, ychen129@syr.edu)

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JOURNAL ARTICLES

- **Chen, Y.,** Lei, J., Cheng, J. (Accepted). What if Online Students Take on the Responsibility: Students' Cognitive Presence and Peer Facilitation Techniques. Submitted to *Online Learning* (formerly *Journal of Asynchronous Learning Networks*).
- Lei, J., Luo, P. H., Wang, Q., Shen, J., Lee, S., & **Chen, Y.** (2016). Using Technology to Facilitate Modeling-Based Science Education: Lessons Learned from a Meta-analysis of Empirical Research. *Journal of Educational Technology Development and Exchange* (*JETDE*), 9(2), 53-83.
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- **Chen, Y.**, Yang, J., Guo, W. G. (2012). How Do K-12 Teachers Choose Online Educational Resource? A Model for Assessing K-12 Educational Website (in Chinese). *China Educational Technology*, 300 (1), 94-99.
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- Deng, X., **Chen, Y.**, Yan, Z. W., Wei, Z. (2009). AC Impedance Model of Array Electrodes in Multisensor Fusion System for Two-phase Flow Measurement, *IEEE Transactions on Instrumentation and Measurement*, 59(6), 1722-1726.

CONFERENCE PROCEEDINGS

- **Chen., Y**. & Hall., J. (2017, April-May). Online Learners' Cognitive Presence and Peer Facilitators' Contribution: When Facilitation Scripts Are Used. From the *AERA Online Paper Repository: http://www.aera.net/repository*. American Educational Research Association (AERA).
- **Chen, Y.**, Yu, B., Zhang, X. Yu., Y (2016, April). Topic Modeling for Evaluating Students' Reflective Writing: A Case Study of Pre-service Teachers' Journals. In *Proceedings of the 6th International Conference on Learning Analytics and Knowledge* (pp. 1-5). ACM.
- **Chen, Y.** & Lei., J. (2016, April). Towards Higher-level Cognitive Presence in Online Inquiry Dialogue: What's the Pattern and How to Facilitate? From the *AERA Online Paper Repository: http://www.aera.net/repository*. American Educational Research Association (AERA)
- **Chen, Y.** (2015). Automated Content Analysis of Students' Cognitive Presence in Asynchronous Online Discussion. In *Proceedings of World Conference on Educational*

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- **Chen, Y.**, Koszalka, T. (2015). Deepen the Meaning of Learning Experience: Online Learners' Cognitive Presence in Self-Directed Instructional Design Inquiry. From the *AERA Online Paper Repository: http://www.aera.net/repository*. American Educational Research Association (AERA)
- **Chen, Y.**, Koszalka, T., & Luo, H. (2013). Online Learners' Cognitive Presence in Self-directed Inquiry: Evidence from Learners' Reflective Writing. In *Proceedings of 19th Annual Sloan Consortium International Conference on Online Learning* (pp.506-508), Lake Buena Vista, Florida: Sloan Consortium
- **Chen, Y.** (2010). A Qualitative Study on the Learning Behaviors of Learners in A Virtual Community (in Chinese), In *Proceedings of Graduates' Academic Forum among Beijing Colleges 2010* (pp.51), Beijing, China
- **Chen, Y.**, Guo, W. G., Yang, J. (2009). How Do K-12 Teachers Choose Educational Resource? —An Empirical Study on Educational Website Evaluation (in Chinese). In *Proceedings of Kunming Educational Technology Forum 2009* (pp.49-55), Kunming, China.
- Jiang, Y., **Chen, Y.**, Jiang, J. (2009). Colorful World under the Crazy Crayon—Case Analysis of Crayon Physics (in Chinese), In *Proceedings of Conference on Digital Game-based Learning 2009* (pp.18-25), Hongkong, China

CONFERENCE PRESENTATIONS

- **Chen., Y.** (2018). *Effects of Scripted Peer-facilitation on Students' Cognitive Presence in Online Discussion: An Exploration Using Bayesian Approach*. Paper accepted by American Educational Research Association (AERA) Conference. New York, NY, USA, April 13-17, 2018.
- **Chen., Y.** & Hall., J. (2017). *Online Learners' Cognitive Presence and Peer Facilitators' Contribution: When Facilitation Scripts Are Used*. Paper presented at American Educational Research Association (AERA) Conference. San Antonio, TX, USA, April 27-May 1.
- **Chen, Y.**,Yang, T. & Lei, J. (2016). *Emerging Technologies for College Students' Inquiry-based Learning*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT) convention, Las Vegas, NV, USA, October 17-21.
- **Chen, Y.**, Yu, B., Zhang, X. Yu., Y (2016). *Topic Modeling for Evaluating Students' Reflective Writing: A Case Study of Pre-service Teachers' Journals*. Paper presented at the 6th International Conference on Learning Analytics and Knowledge. Edinburgh, UK, April 25-29, 2016.
- **Chen, Y.** & Lei., J. (2016). *Towards Higher-level Cognitive Presence in Online Inquiry Dialogue: What's the Pattern and How to Facilitate?* Paper presented at American Educational Research Association (AERA) Conference. Washington D.C., USA, April 8-12, 2016.
- **Chen, Y.**, Lei, J., & Chen, J. (2015). *Dynamics of Cognitive Presence in Online Learners' Inquiry Discourse*. Poster presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Indianapolis, IN, USA, November 3-7, 2015.
- **Chen, Y**. & Lei, J. (2015). *Does Facilitating Matter in Enhancing Learners' Cognitive Presence in Online Asynchronous Discussion*? Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT), Indianapolis, IN,

USA, November 3-7, 2015.

- Tao, D., **Chen, Y.**, Barmaki, L. (2015). *Use Text Mining to Make Collective Knowledge Progress in Online Discourse Visible Automatically*. Poster presented at the 11th Annual LearnLab Summer School. Carnegie Mellon University, Pittsburgh, PA, July 13-17, 2015.
- **Chen, Y.** (2015). *Automated Content Analysis of Students' Cognitive Presence in Asynchronous Online Discussion*. Paper presented at World Conference on Educational Media and Technology. Montréal, Québec, Canada, June 22-24, 2015.
- **Chen, Y.** & Koszalka, T. (2015). *Deepen the Meaning of Learning Experience: Online Learners' Cognitive Presence in Self-directed Instructional Design Inquiry*. Paper presented at American Educational Research Association (AERA) Conference. Chicago, IL, USA, April 16-20, 2015.
- **Chen, Y.** (2015). *Students' Intellectual Engagement in Inquiry Discourse, And How to Enhance*. Poster presented in the 2nd Annual All-University Graduate Research Symposium. Syracuse, NY, USA, March 20-21, 2015.
- **Chen, Y**. & Lei, J. (2015). *Facilitating Learners' Cognitive Presence in A Self-directed Online Course*. Paper presented in the Minisymposium of Cyberlearning Technology and Deep Learning Assessment in CSE Education at Society for Industrial and Applied Mathematics (SIAM) conference on Computational Science & Engineering. Salt Lake City, UT, USA, March 14-18, 2015.
- **Chen, Y**., Lei, J., & Chen, J. (2014). *Exploration of Learners' Cognitive Presence in An Inquiry-based Online Course: Evidence from Online Discussions*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL, USA, November 4-8, 2014.
- **Chen, Y**. & Koszalka, T. (2014). *Uncover Online Learners' Cognitive Presence in Their Self-directed Design Inquiry*. Poster presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL, USA, November 4-8, 2014.
- **Chen, Y**., & Lei, J. (2014). *Exploration of Learners' Learning Experience in An Inquiry-based Online Course: Under the Framework of Community of Inquiry*. Poster presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL, USA, November 4-8, 2014.
- **Chen. Y., &** Liu, H. (2014). *Uncover Deep Learning: Assess Online Learners' Cognitive Presence in MOOC*. Paper presented at the Society of Industrial and Applied Mathematics (SIAM) Annual Meeting, Chicago, IL, USA, July 7-11, 2014.
- **Chen, Y.** (2014). *Proper Questions to Address: A Fundamental Issue for Evaluation of Education and Social Programs.* Paper presented at 37th Annual Conference of Eastern Evaluation Research Society (EERS), Absecon, NJ, USA, April 27-29, 2014.
- Lei, J., Luo, H., Wang, Q., **Chen, Y.**, Shen, J., Lee, S. (2014). *Using Technology to Facilitate Modeling-Based Science Education: Lessons Learned from a Meta-Analysis of Research in 2000-2010*. Paper presented at American Educational Research Association (AERA) Conference. Philadelphia, PA, USA, April 3-7, 2014.
- **Chen, Y.**, Koszalka, T., & Luo, H. (2013). *Online Learners' Cognitive Presence in Self-directed Inquiry: Evidence from Learners' Reflective Writing*. Paper presented at the19th Annual Sloan Consortium International Conference on Online Learning. Lake Buena Vista, FL, USA, November 20-22, 2013.

- **Chen, Y.**, Guo, W. G., & Luo, H. (2013). *Knowledge Sharing in A Virtual Community of Online Learning Facilitators: A Case in A National Distance Education Program in China*. Poster presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Anaheim, CA, USA, October 29-November 2, 2013.
- **Chen, Y.**, Lei, J., & Luo, H. (2013). *Using Activity Theory to Guide Educational Technology Design and Integration: The Lessons from 2005 to 2011*. Poster presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Anaheim, CA, USA, October 29-November 2, 2013.
- Luo, H., Koszalka, T., & **Chen, Y.** (2013). *Case-Based Online Learning Module: Design Features, Perceived Usefulness, and Impacts on Learning*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Anaheim, CA, USA, October 29-November 2, 2013.
- Lu, L. Y., Wang, W., **Chen, Y.** (2013). *Measuring Chinese Pre-service Teachers' Perceptions in Technological Pedagogical Content Knowledge Development*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Anaheim, CA, USA, October 29-November 2, 2013.
- Shen, J., Lei, J., Namdar, B., Lee, S., Luo, H., & **Chen, Y.** (2013). *Synthesizing Modeling-based Instruction in Science Education from 1980 to 2010***.** Poster presented at the National Association of Research in Science Teaching (NARST) Annual Meeting, Wyndham Rio Mar, Rio Grande, Puerto Rico, April 6-9, 2013.
- **Chen, Y.**, Lei, J., & Luo, H. (2012). *An Investigation of How Digital Storytelling Affects Young-aged Students' Learning: Lessons from the Practice in an Art Classroom*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Louisville, KY, USA, October 30-November 3, 2012.
- Luo, H., Koszalka, T., & **Chen, Y.** (2012). *Effect of Visual Cues in Multimedia Case-Based Instruction: Evidence from Eye Tracking Technology*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Louisville, KY, USA, October 30-November 3, 2012.
- Luo, H., Lei, J., & **Chen, Y.** (2012). *Using Technology to Facilitate Modeling-Based Science Education: Lessons Learned from the Past Ten Years*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology (AECT). Louisville, Kentucky, USA, October 30-November 3, 2012.
- Namdar, B., **Chen, Y.**, Luo, H., Lee, S., Lei, J, Shen, J. (2012). *Achievements and Challenges of Modeling-based Instruction (ACMBI) in Science Education from 1980 to 2009.* Poster presented at the National Science Foundation PI Meeting, Washington DC, USA, June 13-15, 2012.
- Jiang, Y., **Chen, Y.**, Jiang, J. (2009). *Colorful World under the Crazy Crayon—Case Analysis of Crayon Physics*, Paper presented at the Conference on Digital Game-based Learning, Hongkong, China, December 18-19, 2009.

GRANT

- Chen, Y. (2015). PI. Learn Through Dialogue: Online Learners' Cognitive Presence in Reflective Inquiry Discourse, School of Education Creative Research Grant, Syracuse University. Funded $700

PROFESSIONAL AFFILIATIONS

- Association for Educational Communications and Technology, 2011-2016
- Sloan Consortium for Online Teaching and Learning, 2013-2014
- Eastern Evaluation Research Society (EERS), 2014-2015
- Society for Industrial and Applied Mathematics (SIAM), 2015-2016
- American Educational Research Association, 2015-present
- Association for Advanced Computing in Education (AACE), 2015-2016
- Society for Learning Analytics Research (SoLAR), 2015-2016

TEACHING EXPERIENCE

Undergraduate Course:

- Instructor (face to face): IDE 201- Integrating Technology into Teaching I, Syracuse University, Syracuse, NY, 2014 Spring & Fall, 2015 Spring & Fall, 2016 Spring & Fall, 2017 Spring

Graduate Course:

- Teaching Assistant (online): IDE 611-Technologies for Instructional Settings, Syracuse University, Syracuse, NY, 2015 Fall
- Teaching Assistant (blended): Educational Technology, Peking University, China, 2009 Fall
- Teaching Assistant (face to face): Educational Psychology, Peking University, China, 2008 Fall

K-12 Class:

- Teaching Assistant (face to face): the 1st grade Math and English class, Huntington School, Syracuse, NY, 2012 Spring
- Teaching Assistant (face to face): k-2 Art class, Central New York Chinese School, Manlius, NY, 2011 Fall

Teacher Professional Development:

- Instructor (online): National Teacher Training Program in Kweichow Province, China, 2009 Fall
- Instructor (face to face): Needs-Based Educational Technology Training Program for Rural Teachers in Shanxi Province, China, 2009 Spring
- Teaching Assistant (online): National Teacher Training Program in Sichuan Province, China, 2009 Fall

SERVICE

Professional Service:

- *Reviewer*, American Educational Research Association 2017 Annual Meeting, Learning Science SIG, 2016

- *Reviewer*, American Educational Research Association 2017 Annual Meeting, SIG-Online Teaching and Learning, 2016
- *Reviewer*, American Educational Research Association 2016 Annual Meeting, Learning Science SIG, 2015
- *Reviewer*, The Annual Conference of Association for Educational Communications and Technology, 2015
- *Session Chair*, Concurrent session for World Conference on Educational Media and Technology, Canada, June 2015
- *Facilitator* in Concurrent session, The Annual Conference of Association for Educational Communications and Technology, US, November 2013
- *Facilitator* in Concurrent session, The Annual Conference of Association for Educational Communications and Technology, US, November 2012

Community Service:

- *Committee Member,* Teaching and Leadership Committee in School of Education, Syracuse University December 2013-December 2014
- *Committee Member,* Curriculum and Degree Committee in School of Education, Syracuse University September 2013-May 2014
- *Volunteer*, War Zones Topic of Symposium: Conversation of Deconstructing the War Zone, Syracuse University January 2013
- *Project Chair,* Setting up the department project lab, Instructional Design, Development, & Evaluation, Syracuse University September 2012-December 2012
- *Co-Chair,* Department New Student Orientation, Instructional Design, Development, & Evaluation, Syracuse University August 2012
- *Volunteer*, Say Yes to Education, Huntington School, Syracuse February 2012-May 2012
- *Volunteer*, Open School for Migrant Workers, Peking University, China September 2008-January 2009
- *Academic & Career Advisor* of Undergraduate Class 0608, Beijing Jiaotong University, China September 2006-July 2008