Relationship Between Metacognition and Online Community of Inquiry in an Online Case-Based Course

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Abstract
This study explored students' perceived metacognition (self-regulation and co-regulation) in relation to the online presence within the Community of Inquiry (CoI) framework in an online case-based instruction (CBI) course. Forty-seven online graduate students enrolled in an instructional design course participated in the study. Data were collected through CoI survey instrument and shared metacognition questionnaire online survey. The findings revealed that students perceived cognitive presence is higher and less variable among three online presences and metacognition in online CBI. The correlation between two interdependent dimensions of metacognition (self-regulation and co-regulation) was significantly high. Also, co-regulation showed stronger relationships with the three online presences (social, teaching, and cognitive) than self-regulation. Additionally, social presence demonstrated the strongest association with both self-regulation and co-regulation, followed by cognitive presence. These results suggest that students with higher perceived social presence tend to have high metacognition. However, students with higher perceived teaching presence are relatively less likely (or unlikely) to have higher metacognition as teaching presence was found to be the most variable among students, which means that teaching presence was perceived differently.

Keywords: online case-based instruction, metacognition, Community of Inquiry, self-regulation, co-regulation

Sadaf, A., Kim, S. Y., & Olesova, L. (2022). Relationship between metacognition and online Community of Inquiry in an online case-based course. *Online Learning, 26*(4), 79-93. DOI: 10.24059/olj.v26i4.3474

There is a growing need to understand the process of collaborative thinking and learning in an increasingly connected world (Garrison & Akyol, 2015). The Community of Inquiry (CoI) framework has the capability of capturing the collaborative construction of personally meaningful and shared understanding in the online community of learners (Garrison, 2022). The CoI framework consists of three overlapping presences: cognitive presence, social presence, and teaching presence. These provide the theoretical and methodological tools to explore the complexities of metacognition in collaborative and purposeful learning environments (Garrison et al., 2010; Garrison & Akyol, 2015). One of the core elements of the CoI is the development of students' critical thinking skills focused on the construction of individual (self) and shared (others) understanding (Garrison, 2022). This element is known as cognitive presence that guides the construction of meaning through reflection and discourse (Garrison et al., 2001). Cognitive presence is operationalized through the Practical Inquiry model that supports the dynamics of reflective thinking and a collaborative inquiry process (Garrison et al., 2001). Second element, social presence that is defined as the ability to project oneself as an actual person both socially and emotionally in an online environment (Garrison et al., 2000). Finally, the third element is teaching presence that is defined as "the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Anderson et al., 2001, p. 5).

To enhance the quality of online courses and to create a meaningful experience for students, it is important to understand shared learning environments and strategies that can support the development of students' metacognitive processes. In an online CoI, metacognition is defined as a set of higher knowledge and skills to monitor and regulate cognitive processes of self and others (Garrison & Akyol, 2015). Metacognition is a required cognitive ability to achieve deep and meaningful learning that must be viewed from both an individual and social perspective (Garrison & Akyol, 2015). Metacognition within the online CoI is central to the cognitive presence and collaborative inquiry process. Moreover, metacognition becomes shared because thinking and learning are collaborative within the online CoI (Garrison, 2022). However, according to Garrison (2022), the role of metacognition in developing the necessary awareness and regulation for responsible thinking and learning in shared learning environments has not been emphasized enough.

Research suggests that understanding how metacognition manifests in a shared learning environment can help select effective instructional strategies to guide deep and meaningful learning outcomes (Garrison, 2022). One of such instructional strategies can be considered case-based instruction (CBI). Studies found that CBI can help in facilitating deep and meaningful learning through shared collaborative experiences (Koehler et al., 2022; Sadaf et al., 2021). CBI provides favorable conditions where students can be aware of (monitor) and regulate (manage) thinking through the shared inquiry processes (Koehler at al., 2020). Within the CBI, students usually begin by understanding the case problems from their individual perspectives. Following Garrison (2022), this phase can be defined as self-regulation because it consists of learners' self-awareness (monitoring) and self-regulation (managing) of their own cognition. Only after individual understanding of case problems, learners can get a deeper understanding and connections with the shared collaborative knowledge (social perspectives or others). This CBI phase can be defined as monitoring and managing a complex shared learning dynamic or co-regulated learning (Akyol & Garrison, 2011; DiDonato, 2013; Garrison, 2022).

While, CBI has the potential to promote cognitive presence and metacognition in online CoI because students can reach higher levels of cognitive presence that require tasks situated in

CBI (Sadaf et al., 2021), there is a need for more research to examine self-regulation and co-regulation for the problem-solving process (DiDonato, 2013; Koehler et al., 2022; Morueta et al., 2016). CBI instruction includes problem-solving process when students are required to find the solution and justify it while problem-solving process itself without CBI not necessarily includes cases. It can include only the task or the problem that students are usually asked to solve. In addition, Kills and Yildirim (2018) suggested a need for more research on self and co-regulation so as to comprehend their position, role and interaction with the other CoI constructs. To answer this call for further investigation, the purpose of this study is to explore students' perceived metacognition in relation to three online presences—teaching, social, cognitive—in the CoI within an online CBI course.

Literature Review

Metacognition

Studies have started extensively examining metacognitive processes in collaborative learning contexts (Kilis & Yildirim, 2018; Koehler et al., 2020; Koehler et al., 2022) and, specifically, recognizing individual and social regulatory processes. Metacognition is defined as the central part of any learning process to monitor and control cognition in terms of interaction between individuals and others (Akyol, 2013; Garrison & Akyol, 2015). Metacognitive processes include setting goals and monitoring and controlling progress towards goals (Akyol, 2013; DiDonato, 2013). Metacognition has become an important part of the collaborative inquiry process in order to monitor and manage the learning process for both personal and collaborative experiences. However, studies also reported that a truly collaborative environment requires more engaged approaches to help learners construct new meaning and share understanding with others (Garrison & Akyol, 2015).

The CoI framework can help understand the complex nature of truly collaborative dynamics as the framework theoretically describes the complexities and conduct of learning collaboratively (Garrison, 2017). The CoI framework encourages students to be self-reflective in building metacognitive development in collaborative learning. Moreover, following Garrison (2022), we support the statement that metacognition within the CoI consists of two components—monitoring (awareness) of the inquiry process and managing (regulation strategies) (Garrison, 2022) because the CoI requires students to collaborate for critical, creative, and innovative thinking. In this sense, metacognition can be seen as a medium between one's internal knowledge and collaborative activities. Further, managing collaborative learning requires both individual (personal dimension) and social (shared dimension) responsibilities that lead to an understanding of self-regulated and co-regulated learning (DiDonato, 2013; Garrison, 2022). Self-regulation in the CoI is accompanied by co-regulation as a group increases awareness of the learning process and takes responsibility to manage collaborative inquiry (Garrison & Akyol, 2015). According to Garrison and Akyol (2015), self-regulation of cognition reflects metacognitive monitoring and managing strategies and skills when the individual is engaged in the personal reflective learning process. On the other hand, "co-regulation of the cognition dimension reflects metacognitive monitoring and managing strategies and skills when engaged in a collaborative learning process as a member of a purposeful and coherent group of learners" (Akyol, 2015, p. 68).

Case-Based Instruction

The CoI provides the framework to understand the dynamics of metacognitive processes in collaborative inquiry learning environments where self-regulation and co-regulation are two interdependent dimensions. The difference between the two dimensions reflects the transition from an individual ("I am aware of my effort") to a shared process ("I challenge others' perspectives") (Garrison, 2017). One instructional strategy that allows students to actively monitor and manage metacognitive processes in collaborative learning is case-based instruction (Koehler et al., 2022). Case-based instruction (CBI) has been one of the most effective instructional strategies to ill-structured problem-solving skills because it provides rich contexts for farming problems and facilitates experience-based knowledge construction (Choi & Lee, 2009). The CBI as an effective strategy helps develop a sense of social responsibility, understand the contextuality and engage students in critical thinking and analytical reflection (Choi & Lee, 2009). The CBI designed within the CoI framework sets favorable conditions for collaborative thinking and learning. CBI involves students' engagement with professional problems and includes (1) narratives covering real-world situations for individual knowledge construction (self-regulation) and (2) collaborative discussions offering students to work together to solve the problem (co-regulation) (Ertmer & Koehler, 2014).

The CBI as an instructional strategy helps facilitate students' critical thinking and cognitive presence (Morueta et al., 2016; Richardson & Ice, 2010; Sadaf & Olesova, 2017). When instructors implement authentic cases into their courses, they provide students with an opportunity to work with complex real-life problems faced by professionals. Students engage in discussions of cases with their peers and use multiple perspectives when they analyze authentic problems (Stepich et al., 2001). When students respond to the real-life problems, their level of cognitive presence is usually at the high level of resolution because they need to find and justify why the solution can help solve the problem (Richardson & Ice, 2010; Richardson et al., 2012). CBI as an inquiry approach provides students with the conditions for the transition from individual knowledge construction to collaborative learning because they can interact with each other, support each other's participation, build and reshape new knowledge, facilitate collaborative knowledge construction, and support the thinking process (Koehler et al., 2022). The inquiry within CBI offers students an opportunity to explore and discover new information, and take responsibility and control of the learning transaction. The CBI offers a medium for students to monitor their understanding when completing the learning task. As a result, students are able to control their cognitive process, and the more accurate their monitoring is, the more able they are to regulate the learning process (Koehler et al., 2020).

Social Presence, Cognitive Presence, and Teaching Presence

CBI as an instructional strategy to facilitate collaborative learning can create comfortable conditions for social presence due to interactions among students (Akyol, 2009). When communication context is designed through learning activities, it can impact students' perceptions of social presence. The following categories of social presence are identified within the online CoI: affective or emotional expression, open communication, and group cohesion (Garrison & Arbaugh, 2007). Social presence as one of the essential elements of the CoI framework can enhance students' cognitive processes through social interaction. Moreover, social presence can predict students perceived cognitive presence; it also can promote cognitive presence by sustaining and supporting creative thinking in a community of learners (Akyol &

Garrison, 2019). The CBI provides dynamic development of cognitive processes because students work on solving real-world problems; they need to interact with each other.

Another essential element within the CoI is teaching presence that helps establish and maintain an effective social and cognitive presences (Garrison et al., 2010b). In addition, teaching presence contributes to the creation of an online community of learners to provide opportunities for social interactions. According to Garrison and Akyol (2015, p. 67), teaching presence can help "understand metacognitive development by encouraging students to take personal responsibility for their learning (self-regulation) through facilitating discourse and resolving misunderstandings collaboratively (co-regulation)." It seems that an online instructor could be the only one who is responsible for designing, planning, facilitating, and teaching deep thinking and meaningful learning outcomes.

To help students develop cognitive and social presence, teaching presence can be provided by an online facilitator or students themselves (Killis & Yildrim, 2018). Therefore, CBI as an effective instructional strategy has the potential to help students create a teaching presence themselves when they are engaged in social interactions while solving case problems. However, not any CBI can provide students with conditions for meaningful learning outcomes. Sometimes, students find CBI challenging because they experience negative attitudes or personal conflicts with others or they do not find relevance in CBI, which results in a lack of engagement (Koehler et al., 2020). While the strength of the CBI instruction is to guide students through all the phases of cognitive presence as a process from exploring the case up to solving the case, some students still may find it difficult to achieve higher phases of cognitive presence (i.e., solving the case) (Koehler et al., 2020) because the problem-solving tasks require self-organization and self-management skills. Not all students are able to organize and manage their own learning goals for active participation, select time to follow up with others, contribute meaningfully to CBI, decide what to read or pay attention to, and adjust learning strategies based on others' comments (Koehler et al., 2020). Therefore, it is important to understand how students can monitor and manage individual and collaborative cognitive processes to navigate learning in a shared environment within the CBI context.

Purpose of Study

Although metacognition is an important intellectual skill that plays a critical role in achieving deep and meaningful learning experiences, research on how metacognition (self-regulation and co-regulation) is manifested in students' ability to monitor and manage learning within the CBI context in the online CoI environment is limited. It is not clear how deep thinking and learning can be designed in shared collaborative contexts through discourse and students' ability to monitor and manage the collaborative inquiry process. For example, DiDonato (2013) examined how middle-school students used collaborative authentic semi-structured tasks to develop self-regulated learning. The researcher found that co-regulated interactions can contribute to individual students' self-regulation when they were given a complex semi-structured task. DiDonato (2013) suggested that further research is needed to examine and support co-regulatory processes for problem-solving processes. Similarly, in an advanced CBI course, Koelher et al. (2020) explored individual students' regulation experiences. Researchers found that students did not have effective regulation strategies to deal with the complexity of shared ownership. Researchers suggested that opportunities should be designed to help students individually and socially regulate their learning. Koelher et al. (2020) noted that further research is still needed to determine how students can regulate learning in a shared inquiry environment.

Another study by Koehler et al. (2022) explored and provided insight into how students purposefully participated within the CBI context to support group (co-regulation) and individual (self-regulation) problem-solving process. Researchers found that students' awareness (self-regulation) played an important role in their abilities to have stronger problem-solving strategies. Koehler et al. (2022) suggested that more research is needed to examine how students regulate their understanding of complex problems and how they develop strategies to overcome challenges of the problem-solving process.

Although DiDonato (2013) and Koehler et al. (2020) studies shed some light on students' self- and co-regulated processes during collaborated inquiry-based learning environments, they did not use a theoretical lens specifically focused on exploring students' metacognition and its relationship with online presences within an online CoI. The use of a well-established CoI framework that emphasizes both the personal and shared learning experience to support and sustain metacognition in a collaborative-constructivist learning environment might provide more insight and strengthen the results of the previous studies. Therefore, the purpose of this study is to explore the students' perceived metacognition in relation to an online presence with the CoI in an online CBI course. The following questions will guide this study:

1. What are student perceptions of online presences (teaching, social, and cognitive) and metacognition (self- and co-regulation) in online CBI courses?
2. What are the relationships between students' perceived metacognition (self- and co-regulation) and the three presences in online CBI courses?
3. Which of the three presences reveals the strongest association with metacognition in online CBI courses?

Theoretical Framework

Garrison et al.'s (2000) CoI was used as the theoretical framework to understand how metacognition is manifested in a shared learning environment. The CoI framework provides a model of cognition that operationalizes inquiry with the prospective to understand metacognition in an online learning environment (Akyol, 2013). The CoI framework was used as a guide to examine how students deal with multiple opportunities to be self-reflective and communicative to support and sustain metacognition in a collaborative-constructivist learning environment (Garrison & Akyol, 2015). The commonality between metacognition and the CoI is the interplay between internal knowledge construction and collaborative learning activities. The CoI framework was used because it emphasizes both the personal (reflective) and shared (collaborative) worlds of a learning experience, which is consistent with metacognition in a shared collaborative environment and the integration of the personal and shared view of metacognition (Garrison et al., 2010a).

Methods

Participants

A purposeful sample of 47 graduate students from a public university located in the southeast of the U.S. was selected to participate in this study. The sample was majority female (76.6%, n = 36; male: 17.0%, n = 8; unknown: 6.4%, n = 3) and approximately half (57.4%, n = 27) of them were more than 36 years old. The majority (76.6%, n = 36) of the participants have taken more than four online courses and most (83.0%, n = 39) of them rated themselves as being very comfortable with participating in online courses. Table 1 provides detailed information about the study participants. The sample was included in the study because students were

enrolled in the online graduate course designed based on a CBI to learn instructional design (ID) skills.

Table 1

Demographic Information of Participants (n = 47)

	N	%		N	%
Gender			Age		
Male	8	17.0	21–25	5	10.6
Female	36	76.6	26–30	11	23.4
Prefer not to answer	3	6.4	31–35	4	8.5
Student status			36–40	15	31.9
Graduate certificate	4	8.5	More than 40	12	26.5
Master's	43	91.5	Comfort level with online discussions		
Number of online courses taken			Not at all	2	4.3
1	2	4.3	A little	1	2.1
2	4	8.5	Fairly	5	10.6
3	5	10.6	Very	39	83.0
4 or more	36	76.6			

Context of the Study

The study was conducted in an "Advanced Instructional Design" sixteen-week asynchronous online course required for master's and graduate certificate students in the Learning, Design, and Technology program. Students engaged in authentic design activities via participation in an online community of inquiry and participated in two instructor-facilitated case discussions at the beginning of the semester, followed by participation in four student-led case discussions. For each case, students participated in two-week long discussions. First week, students were required to find the problem within the case and then second week provide the solution to those problems. Students were required to co-analyze instructional design problems, work with diverse teams and individuals, develop solutions to real instructional design problems via cases, and give and receive constructive feedback from peers and the instructor.

Prior to participation in the case discussions, students completed individual case analyses in which they reflected on and responded to a number of specific prompts that required students to identify stakeholders, ID challenges, and potential solutions to the problems presented in the case**.** The prompts were designed for students to give each of the issues presented in the cases careful consideration before participating in the class discussions. Then, students participated in weekly discussions and proposed/developed relevant solutions to the issues presented in a case. Finally, at the middle and at the end of the course, students reflected on their development of expertise in solving cases. These activities offered students the opportunity to develop instructional design skills based on real-world cases. Course activities and assignments were designed to help students develop the knowledge, strategies, and attitudes needed to become effective instructional designers. Learning experiences revolve around two major activities: (1) the analysis and synthesis of, and reflection on, instructional design case studies and (2) ongoing reflection on the development of students' instructional design expertise through written case analysis, course discussions, and reflections.

Data Collection

Data were collected from two consecutive years of the same online course taught during the Spring 2021 and 2022 semesters. As the final course reflection assignment, students were required to either write a reflection paper or participate in the online survey administered through Qualtrics. Directions for completing both assignments were provided in the last module of the Canvas online course. The purpose of the study was explained as well as the time commitment required for participation. All 47 students chose to complete the online survey for a 100% response rate. The informed consent statement approved by the Institutional Review Board (IRB) was posted on the web as the opening page of the online survey. All students agreed to participate in the study and signed the consent form by clicking on a button "I agree to complete this survey."

The CoI Survey and the metacognition questionnaire were used to collect data. The CoI survey was developed by Arbaugh et al. (2008) to measure students' perception of teaching presence (TP), social presence (SP), and cognitive presence (CP). The survey consists of 34 five-point, Likert-type items (TP: 13 items, SP: 12 items, CP: 9 items) with the response categories ordered from "1 = strongly disagree" to "5 = strongly agree". The instrument was validated by conducting exploratory factor analysis (EFA) by Garrison and colleagues in 2004. The final three-factor structure of the 34 items was with no cross-loading (Garrison et al., 2004). The 34-item structure explained 53.6% of the variance in the pattern of relationship among the items (e.g., teaching presence 38.47%, cognitive presence 9.01% and social presence 6.12%). The CoI instrument has been also tested and validated with a multi-institutional data set (Arbaugh, 2007; Swan et al., 2008). The internal consistency reliability of the 34 items was high with a Cronbach's Alpha of .91 for social presence, .95 for cognitive presence, and .94 for teaching presence (Swan et al., 2008). Shea and Bidjerano (2009) conducted confirmatory factor analysis (CFA) and found that the hypothesized model of the 34-item structure was verified as an excellent fit for the data ($\chi 2$ = 11,155.16 (df = 623), pb.00, NFI = .95, CFI = .95, GFI = .95, RMSEA = .08).

Students' perceptions of metacognition were measured using the metacognition questionnaire developed by Garrison and Akyol (2015), which includes 26 five-point, Likert-type items in two dimensions: self-regulation and co-regulation. Each item employs a five-point Likert-type scale, with 1 = strongly disagree and 5 = strongly agree. Garrison and Akyol (2015) conducted an EFA of the instrument. The results confirmed the theoretical structure of the metacognition construct in terms of extracting two factors that are identified as self- and co-regulation of cognition. The authors also conducted an EFA to explore the monitoring and managing sub-elements of self- and co-regulation. The items did not load as hypothesized that there was a correlation among the factors (individual monitoring and managing; group monitoring and managing). As a result, it was difficult to interpret the monitoring and managing sub-elements of self- and co-regulation (Garrison & Akyol, 2015).

In our study, the reliability of the CoI survey and metacognition questionnaire was found to be generally satisfactory, with its Cronbach's alpha value of .96 and .93, respectively. When each of the sub-factors being considered individually, for the CoI survey, the alpha coefficients for cognitive, social, and teaching presences were .88, .91, and .97, respectively. The sub-factor reliability was .92 and .91 for self-regulation and co-regulation.

Simple demographic information was also collected such as gender, age, prior experience with online courses, and the program to which a student belongs. Students were asked to respond

to three sets of survey questions: with a reflection on their CoI, self-regulation, and co-regulation.

Data Analysis

The survey data were analyzed through descriptive statistics using means and standard deviations. In addition, correlation analysis was conducted to explore the relationships between the three presences of CoI (Cognitive, Teaching, and Social) and metacognition (self-regulation and co-regulation) in the CBI course. A set of assumptions required to use a Pearson correlation was examined including normality, linearity, and no presence of outliers. Given that the Shapiro-Wilk test for normality revealed significance for some of the variables, which suggested a violation of the assumption of normality, the Spearman correlation was used which does not require normality or linearity of data.

Results

RQ1: Student perceptions of online presence and metacognition

Results showed, in general, students' perceived cognitive presence was the highest (M = 4.509, SD = .428) among the three types of online presences and two dimensions of metacognition, followed by self-regulation (M = 4.417, SD = .444) (see Table 2). Additionally, students had the lowest rating on co-regulation (M = 4.160, SD =.551). It is also interesting to note that the level of perceived cognitive presence was less variable than others with a standard deviation of .428, meaning that students generally perceived their cognitive presence higher than other types of online presences and metacognition and the tendency was rather consistent across students. By contrast, the level of teaching presence was found to be the most variable among students, having a standard deviation of .718. This suggests that students' perceptions tend to differ in teaching presence.

Table 2

Students' Perceived Cognitive Presence, Social Presence, Teaching Presence, and Metacognition (n = 47)

	Mean	*SD*
Cognitive Presence	4.509	0.428
Social Presence	4.265	0.599
Teaching Presence	4.398	0.718
Metacognition (Self-Regulation)	4.417	0.444
Metacognition (Co-Regulation)	4.160	0.551

RQ2: Relationship between students' perceived metacognition and the three presences

Relationships between cognitive presence, social presence, teaching presence, self-regulation, and co-regulation were explored based on the Spearman correlation (see Table 3). Some pairs of the five variables showed statistically significant relationships, having a correlation value of .390 ~ .653. One interesting finding is that co-regulation showed stronger relationships with the three types of online presences than self-regulation did. Specifically, co-regulation had a statistically significant correlation value of .653 with social presence while self-regulation revealed a significant correlation value of .397. A similar pattern was also observed for cognitive presence and teaching presence but the degree of association was slightly weaker

for these two than for social presence. Also, the correlation between two dimensions of metacognition (e.g., self-regulation and co-regulation) was found to be significantly high with the correlation of .561. This implies that students with high self-regulation tend to have high co-regulation, and vice-versa.

Table 3

Pearson Correlation Coefficients Between Perceived Cognitive Presence, Social Presence, Teaching Presence, and Metacognition (n = 17)

	Cognitive Presence	Social Presence	Teaching Presence	Metacognition (self)
Social Presence	0.528**			
Teaching Presence	0.546**	0.258		
Metacognition (self-regulation)	0.390*	0.397**	0.096	
Metacognition (co-regulation)	0.514**	0.653**	0.228	0.561**

Note. * indicates $p < .01$. ** indicates $p < .001$.

RQ 3: Strength of association between three presences and metacognition

To answer the last research question, correlations between the three presences and metacognition were examined. In general, social presence demonstrated the strongest association with both self-regulation and co-regulation, followed by cognitive presence (see Table 3). By contrast, teaching presence revealed no statistically significant relationship with metacognition with its value of .096 and .228 for self-regulation and co-regulation, respectively. These results suggest that students with higher perceived social presence tend to have higher metacognition while those with higher perceived teaching presence are relatively less likely (or unlikely) to have higher metacognition.

Discussion

This study sought to gain insight into students' perceived metacognition within the online CoI and whether there is a relationship between students' perceived metacognition (self-regulation and co-regulation) and the three CoI presences (cognitive, social, teaching) in an online CBI course.

RQ1: Student perceptions of online presences and metacognition

Results revealed that students generally perceived their cognitive presence as higher than social or teaching presence with a consistent tendency across students. This shows that when students participate in an online course using CBI, they tend to perceive high cognitive presence through collaborative experiences that are designed to encourage a deeper understanding of the issues presented in case problems. This may be due to students' comfort level with online CBI since the students were enrolled in the graduate level course and most of them were very comfortable with participating in online courses. These results corroborate previous studies addressing the importance of cognitive presence for creating an effective CBI in online graduate level courses (Sadaf & Olesova, 2017; Sadaf et al., 2021). For example, Sadaf et al. (2021) noted that when students participate in CBI, they tend to identify high levels of cognitive presence in terms of exploring the problems and creating potential solutions to the issues presented in the case. Similarly, Ertmer and Koehler (2014) noted that case-based discussions can stimulate students' critical thinking by engaging them in constructive discourse related to both the case and content of the course. Scholars have concluded that CBI strategies that require students to

respond to a case to create a solution are beneficial in generating high levels of cognitive presence (Sadaf & Olesova, 2017; Sadaf et al., 2021).

For metacognition, students' perceptions of self-regulation were higher than their perceptions of co-regulation with a consistent tendency across students. This is reinforced in a study that concluded self-regulated learning skills play an important role in the CoI framework and self-regulated students demonstrate a stronger sense of the CoI elements (Cho et al., 2017). Similarly, Garrison and Akyol (2015) also found that individuals' perception of self-regulation was higher than their perceptions of co-regulation. This suggests when students participate in an online CBI course, their perception of self-regulation is higher than their perceptions of co-regulation. However, a complex collaborative environment also requires strong co-regulation skills in understanding peers and instructors. Similarly, Koehler et al. (2020) also found that while students value instructor feedback within the CBI context, some still did not fully consider their contribution or their peers' roles in sharing metacognitive processes (co-regulation). When students embrace co-regulation, their perception of shared ownership is not strong (Koehler et al., 2020). For example, Koehler et al. (2020) mentioned that while some students provide strong feedback, their peers are reluctant to trust their ideas, or they valued ideas only from peers whom they are familiar with.

RQ2: Relationship between students' perceived metacognition and the three presences

In terms of metacognition, it is important to understand cognitive ability consisting of both self-regulation and co-regulation skills in the CoI. In this regard, our results revealed that students with high perceived self-regulation tend to have high perceived co-regulation and vice-versa. This suggests that students participating in an online CBI course perceive they have the knowledge and skills to monitor and regulate cognitive processes of self and others due to the collaborative nature of the course. This may be due to the CBI strategies that required students to co-analyze instructional design problems, work with diverse teams and individuals, develop solutions to real instructional design problems via cases, and give and receive constructive feedback from peers and the instructor. Through these strategies, students contributed to case-based inquiry to develop self and co-regulatory metacognition processes (Garrison & Akyol, 2015).

In addition, students' co-regulation is strongly related to an online presence, except teaching presence. This suggests that when students participate in an online CBI course, they perceive they have high self-regulation, which leads to high co-regulation. Therefore, higher self-regulated students are likely to perceive higher co-regulated learning that leads to a sense of higher social presence, and cognitive presence in an online course using a CBI course. CBI provides learners with the conditions for the transition from individual knowledge construction to collaborative learning because they can interact with each other, support each other's participation, build and reshape new knowledge, facilitate collaborative knowledge construction, and support the thinking process (Koehler et al., 2022). Akyol and Garrison (2011) emphasized the value of the CoI framework and the comprehensiveness of its presences by stating that "each presence directly or indirectly contributes to the development of metacognition" (p. 88).

RQ 3: Strength of association between three presences and metacognition

Results revealed that among three presences, social presence demonstrated the strongest association with metacognition in the online CBI course. This suggests that although the three presences are essential for metacognition in a learning community, in a CBI course, students

with higher perceived social presence tend to have higher metacognition. It is not surprising because, within the online CoI, social presence creates the affective environment for the emergence of social metacognition (Akyol, 2013). Students need to understand each other and what others say without guessing what was said. That's why social interactions create metacognition in a shared environment among members. Students see themselves purposefully within the group with a common purpose (Akyol, 2013). Through social presence, students' own beliefs become available to others creating shared agreement between members (Garrison, 2017). In the CBI course, students were required to co-analyze instructional design problems, work with diverse teams and individuals, develop solutions to real instructional design problems via cases, and give and receive constructive feedback from peers and the instructor. According to Garrison and Akyol (2015), social presence creates the motivational and academic environment essential for metacognition development in a CoI.

On the other hand, results showed that students with higher perceived teaching presence are relatively less likely (or unlikely) to have higher metacognition in a CBI course because the level of teaching presence was found to be the most variable among students meaning students were different in teaching presence. This finding can relate to Koehler et al. (2020) findings that within the CBI context, some students still rely on instructor-set course requirements to guide their own solutions. They perceived the instructor as the most significant in the solution process and they wanted to get specific grade outcomes. These students used to follow well-structured problems instead of an ill-structured process that the CBI context is focused on. Usually, these students trust only instructor feedback and they do not rely on their peers' comments which prevents them from developing co-regulation skills. On the contrary, other students, who might be more advanced in their professional careers or have richer shared participation experience, took responsibility for self-regulating and co-regulating their own learning while receiving support from the community instead of just relying on the teaching presence. This shows that in an online CBI, advanced students' perceptions of social presence are more important for their metacognition development to be successful in collaborative inquiry learning compared to their perception of teaching presence.

The finding of varied teaching presence in our study is reinforced by previous studies of CBI that an advanced graduate course may require instructors to plan and implement regulation strategies by encouraging, supporting, and challenging advanced students without being too directive or authoritative or where instructor attention and facilitation can be minimal or absent (Ertmer & Koehler, 2014). However, instructors still need to support other students' engagement and progression in their case learning process and train them so that they can gain the full benefit of the CBI (Koelher et al., 2020). Therefore, teaching presence can vary within the CBI due to student differences in age, online learning experience, or comfort with online CBI. Students may or may not need more instructional encouragement or support to become metacognitively aware and active in terms of monitoring and managing the inquiry process depending on their experiences (Garrison & Akyol, 2015).

Limitations and Future Research

This study has some limitations that may lead to future research efforts. First, this study is limited in the generalizability of findings due to the small sample size and participants representing only one graduate level program and university. Future studies can use a large sample size with data collected across programs or institutions to further refine the results and implications of this study. Second, this study did not attempt to look at the implementation of

specific case-based instructional strategies that supported metacognition and presences in an online CoI. Investigating student perceptions of metacognition as explained by the three elements of teaching presence—instructional design and course organization, direct instruction, and facilitation—in an online case-based course could be included in future research. Finally, more research examining the relationship between students' self-regulation and co-regulation and their perceptions of CoI within a different context or using a different instructional strategy other than CBI would be a promising direction for future studies.

Conclusions and Implications

This study makes a significant contribution in terms of a relationship between students' perceived metacognition (self-regulation and co-regulation) and the CoI presences (cognitive, social, teaching) in an online CBI course. First, it provides evidence that students have high perceived cognitive presence and self-regulation when they participate in an online CBI course confirming findings from previous studies (Sadaf & Olesova, 2017; Sadaf et al., 2021). In this regard, cognitive presence indicators and self-regulation skills may serve as valuable references for educators when planning CBI in their online courses to support metacognitive skills. Second, although metacognition showed a significant relationship with two presences (cognitive and social), co-regulation revealed a stronger significant relationship than self-regulation. With students' co-regulation providing control over learning, time, and process gaining more importance, especially with online collaborative learning, understanding co-regulation in addition to self-regulation comprehensively promises better results in creating an online collaborative community of inquiry in online CBI. Co-regulation is defined as a dimension that reflects metacognitive monitoring and managing strategies and skills when students engaged in a collaborative learning process as a member of a purposeful and coherent group of learners (Garrison, 2022). For example, within the CBI, students can co-regulate by providing explanations to peers and listening to explanations instead of just pointing out the errors in their work. Third, students with high perceived social presence tend to have higher metacognition for both self-regulation and co-regulation. This emphasizes the importance of collaboration in the CBI course to solve real-world problems as an opportunity for students to become aware of and engaged with others' metacognitive thoughts and activities in addition to their personal reflections. Finally, despite the growing interest in the CoI framework that can provide guidance for designers of online learning, there still seems to be a need in how to use them to inform the design of online collaborative learning experiences that supports students' metacognition. Having a clear understanding of self-regulation and co-regulation and their role in the collaborative inquiry will lead to developing strategies that can promote metacognitive awareness and skills in online CBI and other inquiry-based contexts.

Declarations

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

The authors assert that approval was obtained from an ethics review board (IRB) at the University of North Carolina Charlotte, USA.

The authors declared that no financial support for the research, authorship, and/or publication of this article was received.

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