

Article

Promoting Shared Metacognition in Online Learning: The Practices of Distributed Teaching Presence and the Relationships to Cognitive Presence

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Abstract: This study explores the practices of distributed teaching presence (DTP) to promote students' shared metacognitive responsibilities in online learning. The DTP practices included providing explicit instruction on DTP techniques and guiding students to label their cognitive presence in online discussion. Data were collected through asynchronous online discussion and a questionnaire survey from 53 students enrolled in a graduate-level course at a northeastern private university in the United States. By analyzing the discussion transcripts, students' cognitive and teaching presences were examined to reveal the influence of the interventions on students' learning engagement. Both qualitative and quantitative analysis were conducted to analyze the 2557 messages created by 53 students. The results showed that guiding students to use DTP techniques credibly improved students' teaching and cognitive presence. We also found that students' teaching presence behaviors were positively associated with peers' cognitive presence and their own higher-level learning. The implications for research and practices in designing and facilitating shared metacognitive learning experience are also discussed.

Keywords: distributed teaching presence; cognitive presence; post-labeling; shared metacognition; online learning



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1. Introduction

Online education has shown significant global growth in recent years due to the world-wide pandemic. To surf this trend, universities have increasingly shifted to fully online or hybrid teaching modes (Bao, 2020; Mahmood, 2021). Despite the soaring popularity, online teaching and learning still face great challenges (Caskurlu et al., 2020). One of the most common challenges is the lack of in-person interactions (Turk et al., 2022). In an online environment, students often experience isolation and feel a struggle to fully participate in online activities (Gillett-Swan, 2017). This significantly influences students' engagement in online courses (Robinson and Hullinger, 2008).

Fostering the interdependence between online learners is a promising strategy to address the above issues (Cacciamani et al., 2021). This strategy could be realized by involving students in monitoring and managing the advances of group learning (Garrison and Akyol, 2015). In this case, students are more likely to reflect on the learning process and outcomes. More importantly, they become active members who take on the responsibilities for collective knowledge building (Cacciamani et al., 2021; Garrison, 2022). With

the awareness of the progress of the whole group, students could contribute by sharing expertise and providing support to each other. Such educational influences from others then lead to the development of collaborative inquiry (Coll et al., 2009). Through performing such educational influences, all the members share the teaching responsibility, and this creates a DTP in a learning community (Engel et al., 2013). In this process, students' involvement in DTP activates, changes, or confirms the ongoing interaction among peers (De Backer et al., 2022; Tharp, 2018). Research shows that, in collaborative learning, these opportunities for interaction significantly influence the groups' collaboration and socially shared regulation of learning (Ader et al., 2023; Järvelä et al., 2023) and are positively associated with students' conceptual learning of the subject content in a community of inquiry (De Backer et al., 2022).

Therefore, examining the DTP is essential for understanding collaborative learning dynamics and designing meaningful online learning experiences (Garrison, 2022). However, most previous studies have focused on the instructor's teaching presence. Very little research has examined the DTP created by students. To address the research gap, this study explored the DTP practices in asynchronous online discussions and investigated the influence of DTP practices on students' online learning.

2. Literature Review

2.1. DTP and Shared Metacognition

As an essential element of an educational experience, teaching presence refers to the facilitation, direction, and design of learning processes in a community of inquiry (Anderson et al., 2001). Numerous previous studies examined teaching presence by focusing on the instructor's influence (e.g., Ingram et al., 2024; Shea et al., 2006; Stillman-Webb et al., 2023; Wang, 2022; Zhao and Sullivan, 2017). Yet, Garrison and Anderson pointed out that all course participants should have "the opportunity to contribute to teaching presence" (Garrison and Anderson, 2003, p. 71). Thus, teaching presence is not just teacher presence, but is a distributed function (Coll et al., 2009). All the learners could share the teaching responsibility through collectively monitoring and managing the group's progress (Ataş and Yıldırım, 2024; Haataja et al., 2018; Wertz, 2022). DTP is a term that describes the educational influences of the actions by other participants that aim to promote the cognitive, social, and communicative processes involved in learning (Engel et al., 2013).

DTP is closely associated with students' metacognitive awareness and ability to regulate learning (Garrison, 2022; Paz and Pereira, 2016). Metacognition refers to the awareness of learning and the actions of managing the learning process (Garrison, 2022). Metacognition has long been perceived to relate to self-regulation, focusing on personal thinking and learning (Dinsmore et al., 2008). Yet, in recent years, there has been a growing research interest in the social form of metacognition that examines the responsibilities shared among students in understanding and regulating group learning (Ataş and Yıldırım, 2024; De Backer et al., 2022; Dindar et al., 2020; Garrison, 2022; Li et al., 2024; Vaughan and Wah, 2020; Zheng et al., 2021). Research has found that developing shared metacognition could help students learn how to learn and thus become effective learners (De Backer et al., 2022). When students share such responsibilities, they often feel more comfortable in generating ideas and expressing opinions (Correia and Davis, 2007; Hew, 2015), become more aware of the learning progress (Garrison and Akyol, 2015), and gain more learning and facilitation skills (Murphy et al., 1996). All these benefits then unsurprisingly contribute to an increase in learning participation (Tagg, 1994), improved cohesion of class discussion (Tagg, 1994), and more higher-level cognitive activities in learning (Rourke and Anderson, 2002).

Despite the educational potential of DTP, research in this area is still very limited (De Backer et al., 2020; De Backer et al., 2022; Zheng et al., 2019). So far, the role of instructors'

teaching presence in online learning has been extensively studied (Ingram et al., 2024; Wang, 2022; Yu, 2022; Zhang et al., 2022). Yet, we need to be cautious about applying these findings to the scenario of DTP. This is because student- and teacher-performed teaching presences are different in nature due to the unequal authority relationships between teachers and students (Wertz, 2022). It is very likely that students' perceptions of the two would be unlike (Wang, 2022). Therefore, it is still not clear whether and how DTP could constitute an effective aid in online learning as instructor teaching presence does. More research is needed to examine how DTP could be exercised by online learners and how it could influence online learning. Knowledge in this respect could help inform the design and facilitation of shared metacognitive learning experiences in online environments.

2.2. DTP Techniques in Online Discussion

In recent years, research efforts have been made to examine the phenomenon of DTP in online discussions (Coll et al., 2009; Engel et al., 2013; Guilleumas-García et al., 2020; Paz and Pereira, 2016). Some studies have started to explore practical DTP techniques. For example, Garrison and Akyol (2015) identified six co-regulation strategies that students could use to monitor and manage group learning (e.g., challenging the perspectives of others). De Backer et al. (2022) assigned students the roles of peer tutors and then provided training on peer facilitation skills (e.g., asking thought-provoking questions, stimulating reflection). Gao (2014) developed five discussion strategies (e.g., elaborating and clarifying, making connections) and asked students to label the strategies they used in online discussion.

Based upon the facilitation strategy literature and the empirical data from peer-facilitated online discussions, Chen et al. (2019) described six types of facilitation techniques students spontaneously use to support peers' learning in online discussions. Table 1 shows the DTP techniques:

Table 1. DTP techniques.

DTP Techniques	Definition
Asking questions	Asking guiding or probing questions to deepen or confirm shared understanding (Graesser et al., 2002; Hmelo-Silver and Barrows, 2008);
Making clarification	Explaining why and how by providing explanations, real-world examples, analogies, or diagrams (Atkinson et al., 2003; Capon and Kuhn, 2004; Chuy et al., 2011; Gao et al., 2013);
Promoting connection	Helping students connect new knowledge with prior knowledge and personal experience, find meaningful connections among different aspects of the lesson, and refer to prior discourse (Abrams, 2003; Cross, 1999; King, 1994);
Summarizing and revoicing	Summarizing and revoicing to highlight the important ideas and information (Ng et al., 2012; Zhang et al., 2011);
Providing information	Providing information to keep the discussion progressing, e.g., sharing knowledge, opinion, or experience, as well as referring to authoritative sources and presenting alternative/new perspectives (Hew and Cheung, 2008; Lim et al., 2011; Ng et al., 2012);
Using positive social cues	Expressing positive feelings, such as showing agreement, appreciation, and shared understanding, as well as giving praise and inviting contributions (Hew and Cheung, 2008; Lim et al., 2011).

The above strategies are important ways to materialize teaching presence in a distributed way in online learning environments. When exercised appropriately, applying DTP techniques could help students become active and reflective learners, and thus enhance their cognitive presence development in online learning.

2.3. Cognitive Presence and Its Relationship to Teaching Presence

Cognitive presence is an important indicator of the quality of online learning (Garrison and Anderson, 2003). 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). The concept of cognitive presence is rooted in the critical thinking and reflective thinking literature and operationalized through a Practical Inquiry model (Figure 1) that describes the four phases of cognitive presence development (Garrison and Anderson, 2003; Moore and Miller, 2022).

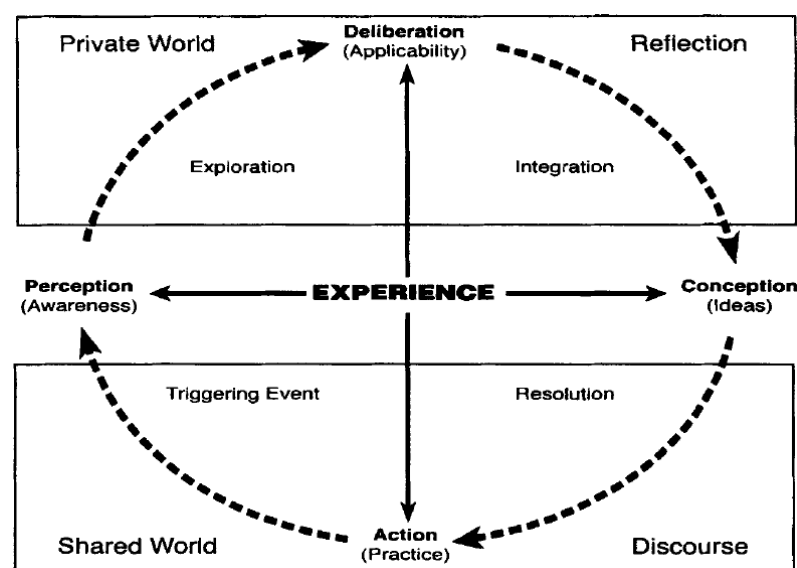


Figure 1. Practical Inquiry model (King, 1994).

The four phases are as follows: triggering event, exploration, integration, and resolution, and they are described as below (Garrison and Anderson, 2003).

- A triggering event is an initiating inquiry state in which students may express feelings of puzzlement or struggle, make attempts to identify the problem, or are assigned with a well-designed task from the instructor.
- In exploration, students explore divergent resources and ideas to collect possible solutions and explanations. At this phase, the information is collected, shared, and stored in a fragmented way without identifying or justifying the relationships hidden in/between the information.
- In integration, students integrate ideas and information through activities of comparing, contrasting, connecting, synthesizing, logical reasoning, elaborating, or explaining. Possible outputs can be a justified explanation or a tentative solution that can guide subsequent actions.
- In resolution, students test the solution in the real world or through a thought experiment in which students describe, in detail, the application process and then justify the results through a chain of reasoning.

To promote cognitive presence, previous research adopted various strategies. Essentially, these strategies create teaching presence to guide and facilitate students in online

learning. For example, [Moore and Miller \(2022\)](#) reviewed studies between 2008 and 2020 to examine how instructors foster cognitive presence in online courses. They identified commonly used strategies such as integrating and facilitating forum discussion, encouraging peer facilitation, and including design elements that aim to improve cognitive presence (e.g., providing participation guidelines and tailoring formative assessments to peer-supported learning). [Wang and Zhang \(2024\)](#) examined the effects of different strategies on learning engagement and knowledge construction, such as contextual strategy, organization strategy, task-driven strategy, and reflective strategy. In addition, post-labeling is also a common strategy applied in online discussions to enhance students' cognitive engagement in online learning (e.g., [Gao, 2014](#); [Jeong and Joung, 2007](#); [Jonassen and Remidez, 2002](#)). Research showed that, through classifying and marking the function of their messages, students performed better in the assigned roles (e.g., critique) ([Weinberger et al., 2001](#)), increased the divergence of the presented ideas ([Weinberger et al., 2004](#)), and were more likely to use strategy to regulate the group discussion ([Gao, 2014](#)).

Research has consistently found that cognitive presence could be causally influenced by teaching presence in online learning environments ([Akyol and Garrison, 2008](#); [Dempsey and Zhang, 2019](#); [Garrison et al., 2010](#); [Shea and Bidjerano, 2009](#); [Su et al., 2024](#)). This is because teaching presence, exercised through instructional design, direct instruction, and discourse facilitation, could create a learning environment that establishes and maintains students' cognitive presence development ([Gibson et al., 2012](#); [Moore and Miller, 2022](#)). Most previous studies examined the teaching presence of instructors. However, researchers have realized that teaching presence could actually be created by all the course participants ([Coll et al., 2009](#)). Encouraging students to exercise teaching presence has a great potential to promote students' shared metacognition and their learning engagement. Yet, currently only a few studies have explored DTP in online learning. More research is needed to gain a better understanding of DTP and how DTP may influence students' thinking and learning in online environments. To address the research gaps, this study examines the practices of DTP in online learning and aims to answer the following research questions:

Q1: *Is there any change in students' cognitive presence and teaching presence in online discussion after being instructed to use DTP techniques?*

Q2: *What is the relationship between student-performed teaching presence and their cognitive presence in online discussion?*

Q3: *Is there any change in students' cognitive presence in online discussion after being instructed to label their cognitive presence in discussion postings?*

3. Methods

3.1. Context

This study was conducted in a 15-week, graduate-level, asynchronous 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 the emerging educational technologies. Each week, students were provided with readings on a particular technology topic, and they were required to participate in asynchronous online discussion of the weekly readings.

In the online discussions, students took turns playing the role of facilitator. Facilitator responsibilities were explained in detail in the course syllabus. Prior to each discussion, a student facilitator received a reminder email about their duties. As a facilitator, students needed to develop 2–3 initiating questions to start the discussion, and then facilitate the ongoing discussion. In this way, students shared teaching presence to monitor and manage the discussion. The instructor monitored the discussion, but how the discussion started and evolved primarily depended on the students themselves.

3.2. Participants

A total of 53 students participated in this study. Among these participants, 46.3% were male, and 53.7% were female; 79.6% were domestic students in the United States, and 20.4% were international students. All the participants had some teaching experience. About 31.5% of the students were in-service teachers or coaches in K-12 schools, colleges, or industry, and 68.5% reported that they had teaching experience as a tutor or teaching assistant.

3.3. DTP Intervention Design

The DTP intervention design was grounded in the shared metacognition model (Garrison, 2022; Garrison and Akyol, 2015). In this study, we aimed to enhance the DTP through fostering shared metacognition among students. According to this model, shared metacognition is materialized through the function of both self-regulation and co-regulation to monitor and manage the collaborative learning process. Thus, two interventions were introduced (Figure 2). First, students were provided with instruction on DTP techniques (Table 1) to increase their awareness of ways to exercise teaching presence. Second, in the middle of the semester, students were provided with instruction on the four phases of cognitive presence and were asked to label their cognitive presence in discussion postings (Figure 3).

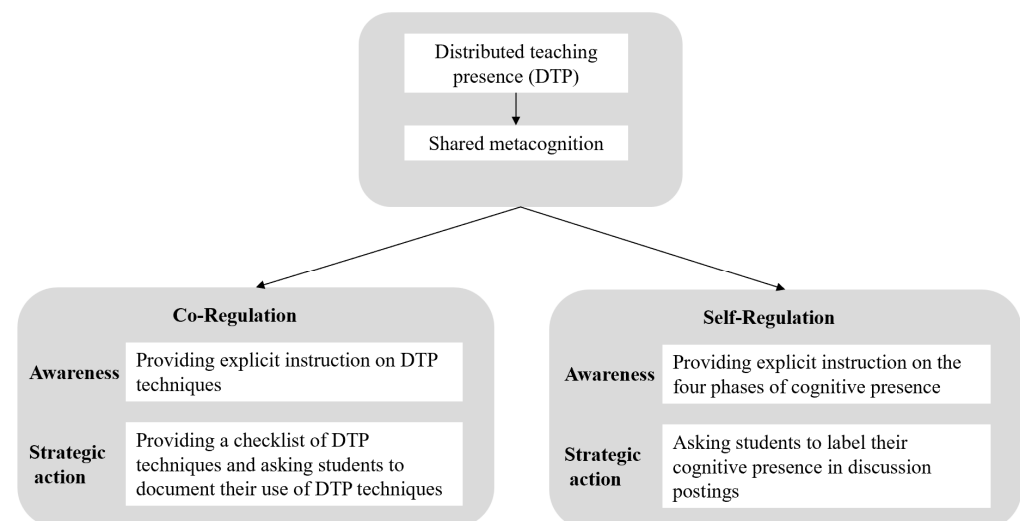


Figure 2. Conceptual framework of the intervention design.

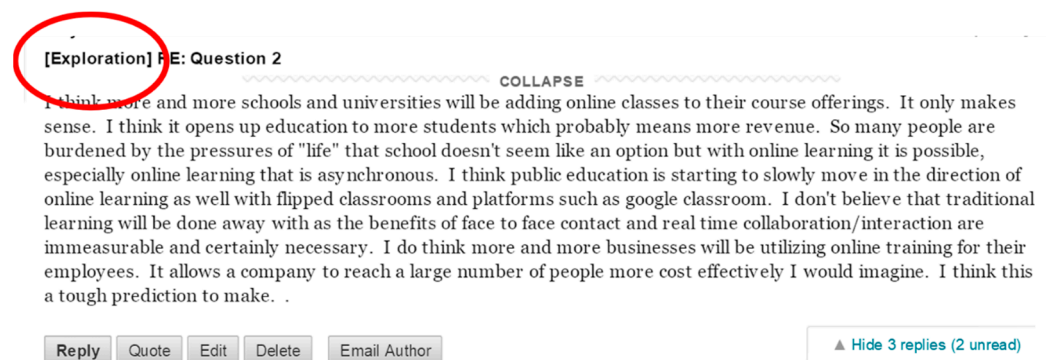


Figure 3. Labeling of posts in terms of cognitive presence phase (s).

Handbooks were provided to train students on using DTP techniques and labeling cognitive presence. The handbooks explained what each DTP technique/cognitive presence

phase was, how DTP techniques could be used, and how to label a discussion posting. For each type of DTP technique/cognitive presence, salient examples from previous students were provided to help them understand the use of DTP techniques and cognitive presence. For the DTP techniques, before each week, the teaching assistant sent the handbook and a DTP checklist to the student facilitator. The student facilitator was asked to read the handbook and then use the checklist to document their use of DTP techniques. Once the discussion week was completed, the student facilitator was asked to submit the DTP checklist to the teaching assistant in this course.

A quasi-experiment was used to explore the influence of the DTP interventions. Two cohorts of students, enrolled in the same course but from two different semesters, were involved as the treatment group and the control group, respectively. The two cohorts were taught by the same instructor. The control group had 17 students, and the treatment group had 36. To minimize the possible influence of group size, the treatment group was further divided into two sub-groups, resulting in 17 students in group A and 19 in group B.

3.4. Data Collection

Discussion transcripts were the primary data source in this study. We excluded void or repeated messages, yielding a total of 2557 messages. Among these messages, 530 were created by the control group, and 2027 were created by the treatment group. In addition, a survey was administered to the participants in the treatment group to collect data on students' perceptions of the interventions. A total of 28 participants completed the survey.

Overall, this study used an Explanatory Sequential Mixed Method to collect data to examine participants' cognitive presence, DTP technique use, and their perceptions of the DTP intervention (Dawadi et al., 2021). There were two interactive phases. The first phase involved qualitative data collection (e.g., online discussion) and analysis to compare cognitive presence and DTP between treatment and control groups. Based on the qualitative findings, the second phase involved quantitative data collection (e.g., survey) and analysis to examine participants' perceptions of the DTP intervention. The data and results from the second phase were used to validate the results obtained from the first phase.

3.5. Data Analysis

3.5.1. Content Analysis

Content analysis was conducted to analyze the discussion transcripts. Table 1 was used as a coding scheme to identify the DTP among students. Table 2 showed the coding scheme that we used to measure the four phases of cognitive presence.

In this study, the unit of analysis was 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). In graduate-level courses, the online discussion messages are often long and cover different topics (Strijbos et al., 2006). This brings in challenges in coding as each message may apply to multiple coding categories. Thus, we segmented each discussion message into units of meaning to break down the complexity (Hew and Cheung, 2011). In the analysis, we followed the procedure suggested by previous studies; thus, we segmented and coded the messages simultaneously (e.g., Hara et al., 2000; Henri, 1992).

Table 2. Coding scheme for cognitive presence (Garrison and 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, developed, defensible, yet tentative hypotheses
	Synthesis	Integrating information from various sources—textbooks, articles, personal experiences
	Solution	Explicit characterization of message as a solution by participant
Resolution	Apply Test Defend	

In coding, each message was read at least twice: we first divided a message into units of meaning, and then we coded each unit of meaning. We searched the evidence in the unit of meaning that corresponded to the description of the codes, such as observable behaviors (e.g., ask a question), connecting words (e.g., because), and indicator sentences (e.g., agreement—“I agree. . .”, expert resource—“the article pointed out. . .”). If there was any ambiguity in interpretation, the content before or after the current unit was examined to improve researchers’ comprehension (Chi, 1997). Additionally, Glaser’s constant comparative method (Glaser, 1965) was used. The transcripts were coded and tested in a “forward-and-backward” way: each unit was compared with the previous units that were coded in the same category; when some aspects in the unit could not be explained by the existing code(s), the code(s) were revised or new codes were added.

A second coder was invited to check the inter-rater reliability. One hundred messages were selected at random for the inter-rater reliability check. Training was provided to help the coder become familiar with the codes and coding process. After the training, the researcher and the coder independently coded the selected transcripts. Discrepancies were

resolved through discussion. The results of the coding were compared using Cronbach's Alpha, resulting in an average reliability of 0.815.

3.5.2. Bayesian Analysis

Statistical analysis was conducted to further analyze the results of the content analysis. We examined the frequencies of codes, reliable differences between groups, and the relationships between the studied constructs.

Bayesian analysis, a mathematical approach that reallocates the credibility of parameter values given to the actual observed data (Kruschke et al., 2012), was performed in this study for quantitative analysis. Compared to traditional Null Hypothesis Significance Testing (NHST), which generates a single point value for each parameter, Bayesian analysis provides more complete information about the parameters by giving probability distributions of all possible values (Kruschke, 2010). Since the reality of the world is changing, variable, and uncertain, using probability distribution to represent the results of data analysis is more appropriate for studying a complex phenomenon (Gelman et al., 2014).

We selected the Bayesian analysis for multiple reasons. First, in this study, multiple conditions were compared to examine the influence of the interventions, and this brought in correction challenges in determining the p -value criteria if using the NHST method (Kruschke, 2010). In addition, the discussion data might violate the assumptions of NHST. This was because a discussion thread was not a list of independent messages. In online discussion, a message was often created to respond to other messages. Meanwhile, the sample sizes were unbalanced between groups. Furthermore, due to the complex nature of human cognition, the discussion data might not be normally distributed.

Bayesian analysis was used to address the above issues, as this approach does not impose any computational constraints and assumptions to data. Unlike NHST, Bayesian analysis can flexibly adapt the model to a complex data distribution/structure, especially when data are non-normal, have a large number of variables, or have many hierarchical layers. In Bayesian analysis, inference decisions are made without referencing p -values. When multiple comparisons are made, no corrections are needed in interpreting the posterior distribution. Thus, there is "no influence from which comparison, and how many" (Kruschke et al., 2012, p. 744). Moreover, the Bayesian approach can handle situations which include a small sample size or an unbalanced sample size across different conditions/groups (Kruschke, 2015).

There are two ways to determine the significance of evidence in Bayesian analysis. First, we examine the posterior distribution of parameter values. For example, to compare two groups for statistical significance, we examine the posterior distribution of mean differences. If the 95% highest density interval (HDI), where the bulk of the most credible values falls, is above zero, we can conclude that the means are credibly different between the two groups. Secondly, we could also examine the Bayes factor (BF). The BF is the ratio of the likelihood of a null hypothesis to the likelihood of an alternative hypothesis. Table 3 presents the thresholds of the BF to define the significance of evidence.

Table 3. Thresholds to define the significance of evidence (IBM SPSS Statistics, 2024).

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

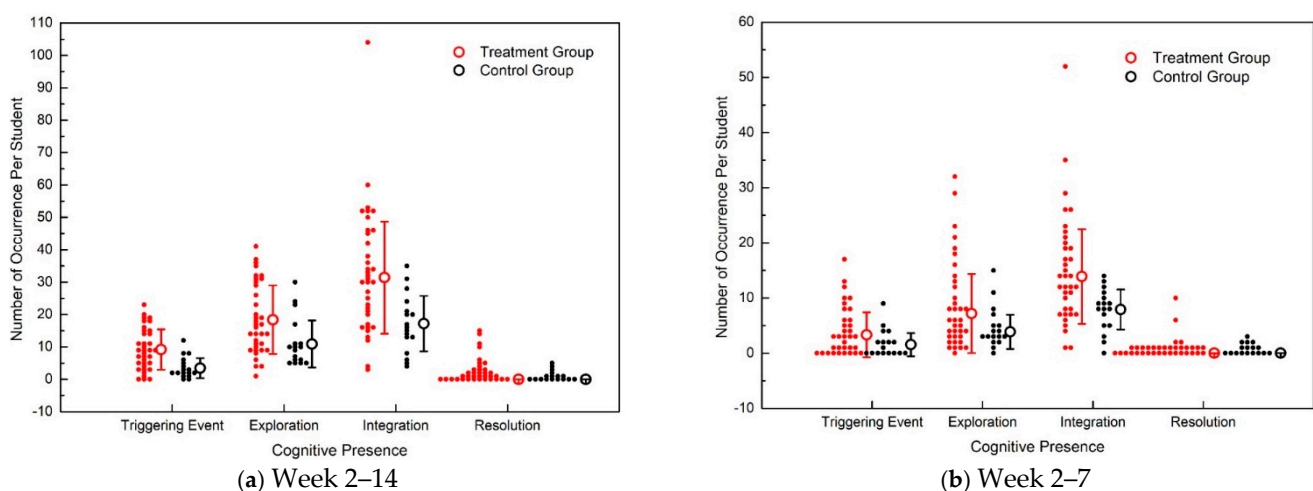
3.6. Ethics Statement

Although a large number of messages were collected in this study, the analysis of data did not include participants' names or other personally identifiable information. Only the content of the message was analyzed, and the focus was on the discussion of the learning content in the course. All the messages were assigned a number ID. In the process of analysis, the messages were tracked or referred through ID rather than participants' personally identifiable information. Only the related researchers had access to the data, and the data were analyzed after the semester was completed. In the event of publications, personally identifiable information was removed, and pseudonyms were used in narratives.

4. Results

4.1. Influence of Providing DTP Instruction on Students' Cognitive Presence

We analyzed the change in students' cognitive presence to examine the influence of providing DTP instruction. The data (Figure 4) showed that the students in the treatment group demonstrated more cognitive presence, including triggering events, exploration, and integration.

**Figure 4.** Comparison of cognitive presence between the treatment and control groups.

An ANOVA (2×4 factorial design) was conducted to examine the significance of the differences. Since the occurrence of resolution was sparse, the resolution type posts were not metric data. This violated the assumption of the ANOVA if using the Bayesian approach. Therefore, the resolution data were excluded in the ANOVA. Figure 5 presents the posterior distribution of frequency differences of cognitive presence between the treatment and control groups. Overall, 95% of the credible values fell above zero. This means that the differences were statistically reliable between the two groups.

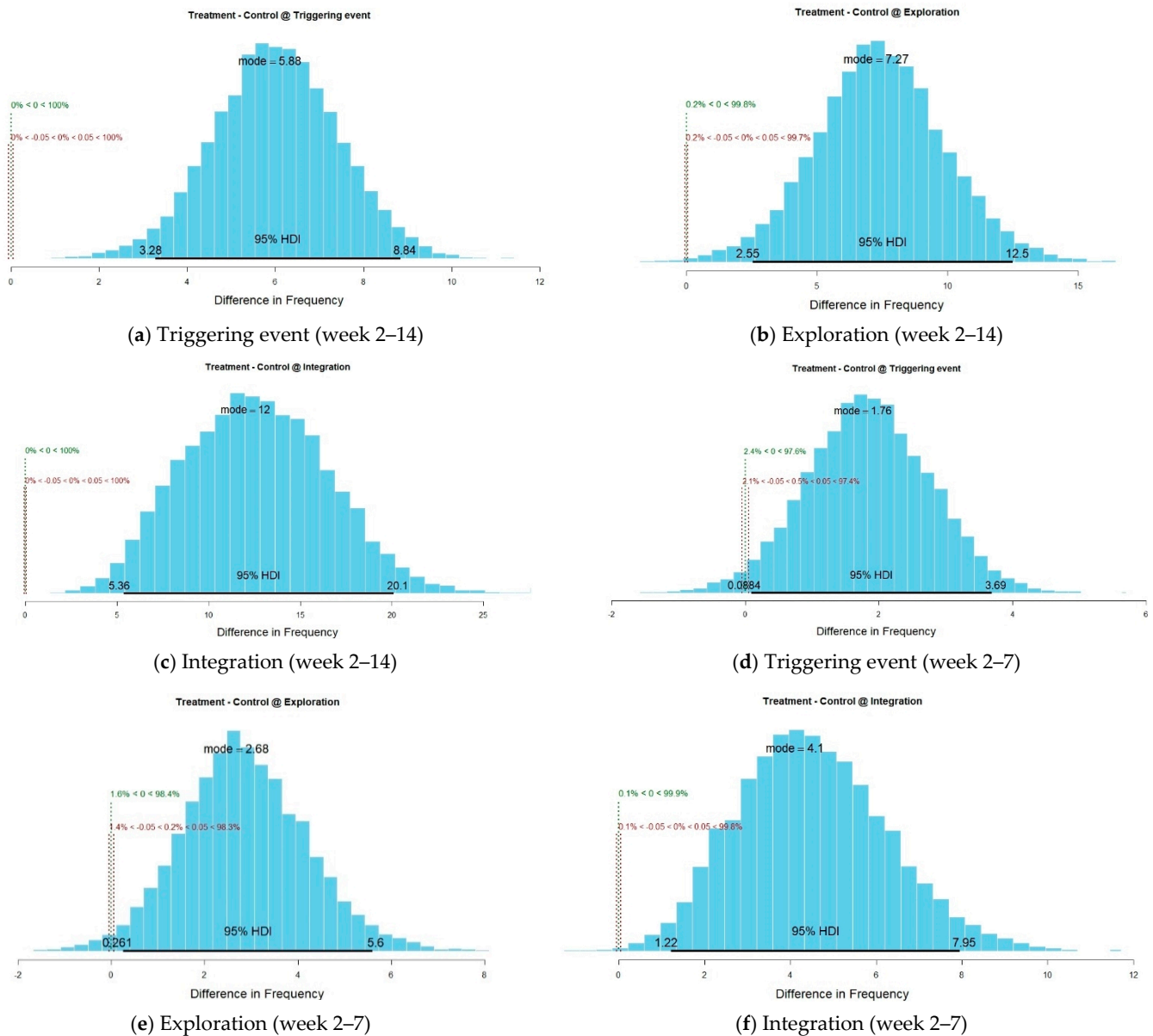


Figure 5. Posterior distribution of the difference in cognitive presence between the treatment and control groups.

4.2. Influence of Providing DTP Instruction on Students' Teaching Presence

We also compared the frequencies of students' teaching presence behaviors to examine the influence of providing DTP instruction. The data showed that, overall, the students in the treatment group demonstrated more teaching presence behaviors (Table 4). The differences were statistically reliable.

Table 4. Pairwise comparison of the occurrences of the six types of teaching presence behaviors.

	Types of Peer Facilitation	Comparison Group	Mean	SD	MD	t	df	Sig.(2-Tailed)	BF
Week 2–14	Ask question	T (N = 36)	5.78	4.162	3.48	−3.301	51	0.002	0.052
		C (N = 17)	2.29	1.759					
	Make clarification	T (N = 36)	3.97	3.776	2.91	−3.107	51	0.003	0.084
		C (N = 17)	1.06	1.088					
	Promote connection	T (N = 36)	3.00	3.243	2.35	−2.937	51	0.005	0.125
		C (N = 17)	0.65	0.786					
	Summarize and revoicing	T (N = 36)	7.86	5.871	6.10	−4.114	51	0.000	0.006
		C (N = 17)	1.76	2.333					
Week 2–7	Provide information	T (N = 36)	9.64	6.681	6.46	−3.744	51	0.000	0.016
		C (N = 17)	3.18	3.468					
	Use positive social cues	T (N = 36)	8.97	6.231	6.56	−4.109	51	0.000	0.006
		C (N = 17)	2.41	2.980					
	Ask question	T (N = 16)	2.33	3.312	1.22	−1.413	51	0.164	1.907
		C (N = 6)	1.12	1.799					
	Make clarification	T (N = 16)	1.97	3.699	1.56	−1.709	51	0.094	1.284
		C (N = 6)	0.41	0.870					
	Promote connection	T (N = 16)	1.42	2.545	1.30	−2.085	51	0.042	0.703
		C (N = 6)	0.12	0.332					
	Summarize and revoicing	T (N = 16)	3.83	5.532	3.30	−2.427	51	0.019	0.372
		C (N = 6)	0.53	1.125					
	Provide information	T (N = 16)	5.00	7.589	4.00	−2.131	51	0.038	0.648
		C (N = 6)	1.00	1.904					
	Use positive social cues	T (N = 16)	4.44	6.456	3.68	−2.304	51	0.025	0.472
		C (N = 6)	0.76	1.640					

Note: SD: standard deviation; MD: mean difference; BF: Bayes factor.

4.3. Relationship Between Cognitive Presence and Student-Performed Teaching Presence

The relationships between cognitive presence and student-performed teaching presence were examined. In particular, we examined the overall association between teaching presence and cognitive presence within threads at the group level, the association between the student individuals' teaching presence and their own cognitive presence, and the association between student individuals' teaching presence and others' cognitive presence. The results (Table 5) showed that, overall, within a discussion thread, the occurrences of cognitive presence were positively and credibly related to the occurrences of student-performed teaching presence. Specifically, we found that student individuals' teaching presence was credibly related to their own cognitive presence (Table 6). Meanwhile, the results (Table 7) also showed that student individuals' teaching presence was positively and credibly associated with others' cognitive presence of integration.

Table 5. Overall correlation between teaching presence and cognitive presence (N = 78).

			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	Lower Bound	0.568	0.413	0.230	−0.082
		Upper Bound	0.799	0.709	0.591	0.344
	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	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	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 and 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	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	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	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

Table 6. Correlation between student individuals' teaching presence and their own cognitive presence (N = 53).

			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 Interval	Lower Bound	0.734	0.354	0.308	0.088
		Upper Bound	0.904	0.722	0.697	0.554
	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	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	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 and 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	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	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	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

Table 7. Correlation between student individuals' teaching presence and others' cognitive presence (N = 78).

			Triggering Event	Exploration	Integration	Resolution
Ask question	Pearson Correlation Posterior	Mode	0.109	0.059	0.408	0.147
		Mean	0.105	0.057	0.395	0.141
		SD	0.012	0.012	0.009	0.012
	95% Credible Interval	Lower Bound	−0.109	−0.160	0.208	−0.072
		Upper Bound	0.320	0.273	0.574	0.353
	BF (Bayes Factor)		7.087	9.794	0.011	4.900
Make clarifications	Pearson Correlation Posterior	Mode	0.145	−0.058	0.435	0.075
		Mean	0.140	−0.056	0.422	0.072
		SD	0.012	0.012	0.008	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	−0.075	−0.271	0.239	−0.142
		Upper Bound	0.350	0.161	0.596	0.289
	BF (Bayes Factor)		4.986	9.851	0.004	9.047
Promote connection	Pearson Correlation Posterior	Mode	0.237	0.266	0.190	0.141
		Mean	0.228	0.257	0.183	0.136
		SD	0.011	0.011	0.012	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	0.022	0.052	−0.029	−0.078
		Upper Bound	0.433	0.458	0.390	0.348
	BF (Bayes Factor)		1.245	0.685	2.781	5.243
Synthesize and revoicing	Pearson Correlation Posterior	Mode	−0.016	−0.016	0.479	0.241
		Mean	−0.015	−0.015	0.465	0.233
		SD	0.012	0.012	0.008	0.011
	95% Credible Interval of Pearson Correlation	Lower Bound	−0.231	−0.232	0.291	0.024
		Upper Bound	0.202	0.202	0.632	0.435
	BF (Bayes Factor)		11.105	11.095	0.001	1.146
Provide information	Pearson Correlation Posterior	Mode	0.136	0.033	0.376	0.111
		Mean	0.131	0.032	0.364	0.107
		SD	0.012	0.012	0.009	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	−0.083	−0.184	0.172	−0.107
		Upper Bound	0.343	0.250	0.549	0.321
	BF (Bayes Factor)		5.531	10.762	0.034	6.999
Use positive social cues	Pearson Correlation Posterior	Mode	0.078	−0.011	0.403	0.192
		Mean	0.076	−0.011	0.390	0.185
		SD	0.012	0.012	0.009	0.012
	95% Credible Interval of Pearson Correlation	Lower Bound	−0.142	−0.228	0.204	−0.027
		Upper Bound	0.289	0.205	0.573	0.392
	BF (Bayes Factor)		8.859	11.157	0.013	2.699

4.4. Influence of Post-Labeling on Cognitive Presence

To examine the influence of asking students to label their cognitive presence, we compared the cognitive presence between the treatment and control groups by focusing on the changes in cognitive presence from weeks 2–7 (without post-labeling) to weeks 9–14 (with post-labeling). As shown in Figure 6, the cognitive presence improvement from the first half to the second half of the semester was not statistically credible enough to show the significance of the differences. The student survey data observed similar findings. The survey results showed that 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 achieve a higher level of learning.

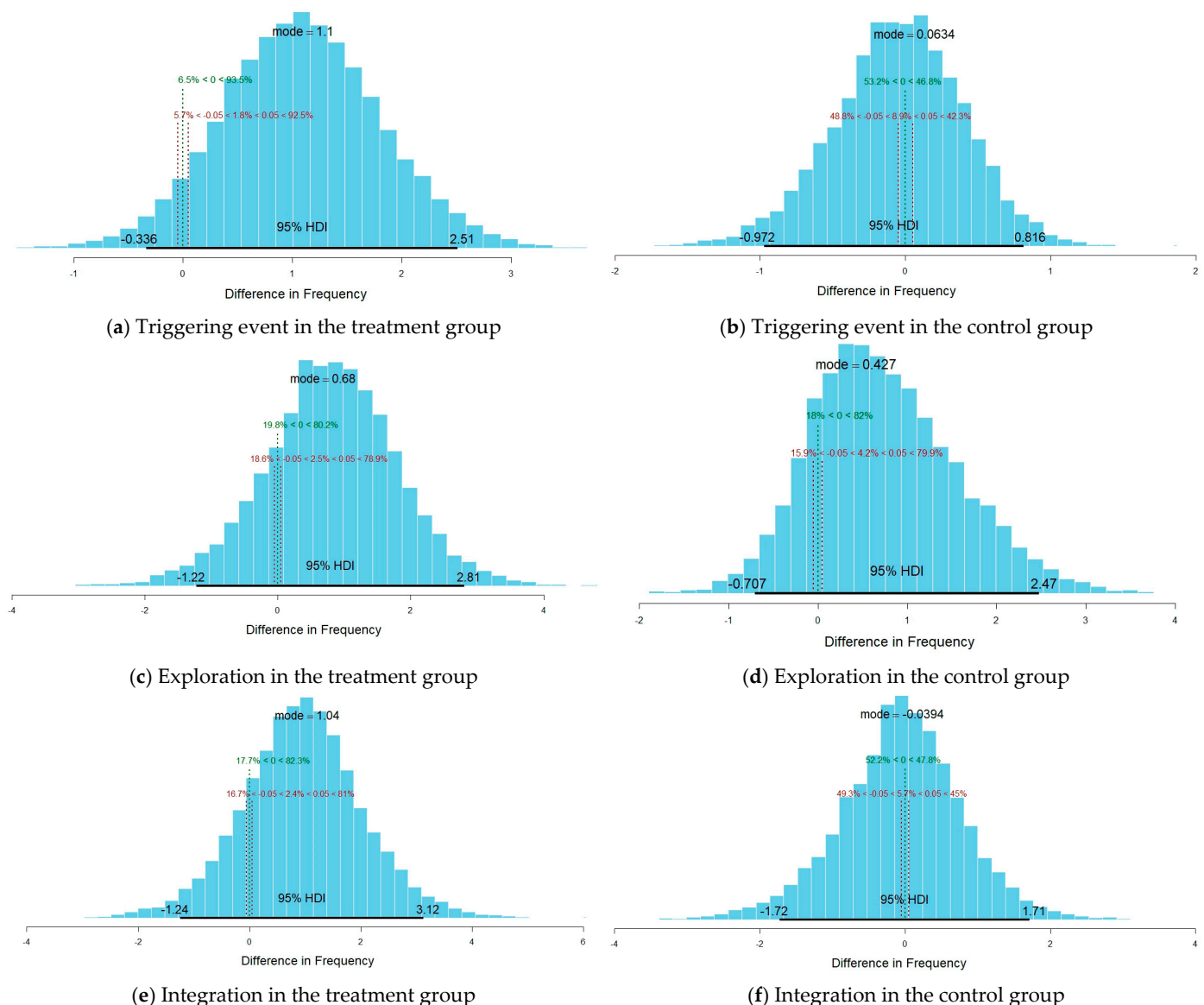


Figure 6. Change in cognitive presence from weeks 2–7 to weeks 9–14 between the treatment and control groups.

5. Discussion

This study implemented DTP practices to promote shared metacognition in online learning. To apply DTP in online discussions, students were assigned the role of facilitators. They were guided to use relevant teaching presence techniques to facilitate online

discussion. Meanwhile, students were also guided to label their cognitive presence in the discussion messages. The results showed that the intervention significantly improved students' teaching presence and cognitive presence in online learning. Below, we discuss the implications of the findings for designing and facilitating shared metacognitive learning experiences.

The first research question examined the influence of providing explicit instruction on DTP techniques. The results showed that students demonstrated credibly more cognitive and teaching presence when being guided to exercise teaching presence. The purpose of helping students become familiar with DTP techniques was to improve their strategy knowledge—an explicit knowledge of the strategies that are effective in facilitating thinking and learning (Wenden, 1991). This knowledge is an essential component of metacognition that could help students find “the best way to practice and reinforce what they have learnt” (Zhang and Goh, 2006, p. 200). When students were guided to be aware of these strategies, they were more likely to practice the strategy as they engaged in the practical experience of being a facilitator (Ben-David and Zohar, 2009). In this case, the students were more likely to show teaching presence behaviors such as asking questions, making clarifications, or synthesizing information. These behaviors, in essence, are a practice of applying appropriate cognitive processes to specific situations to trigger or regulate group learning (Ben-David and Zohar, 2009). In this process, unsurprisingly, students engaged intellectually and thus produced more cognitive presence. This finding suggested that, in teaching, providing students with guidance on DTP techniques to activate group metacognition is necessary for effective collaborative learning. Empirical evidence shows that such metacognition, which could be triggered by appropriate support, can help students perform better on problem-solving tasks and has the potential to influence learning outcomes (Ader et al., 2023; Li et al., 2024; Ouyang et al., 2022; Tang et al., 2023).

The second research question examined the relationship between DTP and cognition presence. The results showed a positive association: when students shared the responsibilities and exercised teaching presence, their cognitive presence was promoted in online learning. This aligns with previous research that found a positive association between learning engagement and shared metacognition (Li et al., 2024; Zheng et al., 2023). Therefore, DTP could be a strategy to increase students' learning engagement. This finding was very encouraging, as it showed that DTP could be materialized in online discussion and shared metacognition was able to enhance students' cognitive engagement in learning. This is because DTP practices could promote the group awareness of regulating the learning process and this awareness could then enhance students' intellectual involvement in problem solving and deep learning (Tang et al., 2023; Zheng et al., 2023). In this sense, teaching presence is essentially collaborative (Garrison, 2022). In a learning community where participants bring in different skills, experiences, and perspectives, the expertise is distributed and thus everyone could be a teacher (Tharp, 2018). Research observed the phenomenon that, even without any related training, students still showed teaching presence behaviors to regulate group learning (Chen et al., 2019). When performed appropriately, DTP could produce a natural power to drive the group to grow spontaneously into an autonomous learning community (Kennedy, 2004). This, to some extent, resonates with the Chinese philosopher Lao-Tzu's concept of “non-action” and the principle of spontaneity in governing a community (Lin, 1948). The teacher should not intervene excessively in students' learning process, especially in adult learning settings. When the teacher applies a light touch, students could have more chances to share the teaching presence and thus become the more active participants in the community. Such an ability to self-regulate the collective inquiry is essential to creating a meaningful collaborative learning experience (Garrison, 2022).

Specifically, the results of this study addressed whether and how the DTP could constitute an effective aid for students' learning. The data revealed two aspects of the relationship between DTP and cognitive presence. First, students' teaching presence was found to be positively associated with their own cognitive presence. This indicated that, in online teaching, having students perform DTP is also an effective approach to enhance their own learning. This was understandable, since a reciprocal link does exist between teaching and learning, and "to teach is to learn twice" (Calvert, 1867; Forrest, 2004). To exercise teaching presence (e.g., synthesizing), students need to comprehend the various viewpoints of peers, and this could help them develop a better understanding of the topic; thus, they are then more likely to show deeper thinking in online discussion (Weiss and Needlman, 1998). In addition, when responding to contrary viewpoints, students create logical self-explanations first to themselves and then to classmates. This process could help repair their defective mental models and thus stimulate further learning (Dandavino et al., 2007). In this sense, exercising teaching presence (e.g., making clarification, asking questions, synthesizing) is also a process of creating and developing cognitive presence. Moreover, in the role of facilitators, students become more aware of the learning process and are more likely to apply strategies to achieve learning goals (Collins et al., 1991). With such meta-awareness and facilitation abilities, students monitor and regulate group learning to maximize the cognitive presence and optimize the learning outcomes (Garrison, 2022). Furthermore, the enhanced metacognition abilities could also help students stay aware of their own learning process and thus modify their learning behaviors (e.g., creating higher levels of cognitive presence) to achieve better learning outcomes (Dandavino et al., 2007).

At the same time, the results also showed that students' teaching presence was positively associated with their peers' higher level of cognitive presence (e.g., integration). This suggested that in teaching, encouraging students to perform DTP techniques is a strategy to trigger active and deep learning. One possible reason is that, in a peer-facilitated environment, students often feel more comfortable brainstorming and challenging others' ideas (Hew, 2015). In this case, they were more likely to become involved in higher-level cognitive activities such as integrating ideas and information, justifying an argument, and proposing a potential solution. In addition, when students exercise teaching presence, they use facilitation techniques such as asking questions, making clarifications, synthesizing and revoicing, providing information, and using positive social cues (Table 5). This peer support could contribute to student engagement at different levels (Steenkamp and Brink, 2024) and is effective in developing deep learning and thus fostering higher-level thinking (Sims et al., 2024). In addition, teaching presence stimulates group metacognition. Such group metacognitive activities are similar to a process of negotiation, in which students constantly monitor their dialogue and then build a mutual understanding of abstract and complex concepts (Gandolfi et al., 2023). Active thinking and learning usually occur in this process (Türkmen, 2024). This finding is uplifting, as it addresses a common issue in online learning that students often tend to stay in their comfort zones by just creating lower-level cognitive presence (e.g., exploration, triggering event) (Garrison et al., 2001; Prasad, 2009; Vaughan and Garrison, 2005). It was already known that instructors' teaching presence could help students move to higher levels of cognitive presence (Prasad, 2009; Shea, 2024; Stein et al., 2013). The results of this study suggested that the teaching presence performed by students could also achieve this purpose. Students themselves could share the teaching responsibility and the teaching presence distributed among students could catalyze the development of cognitive presence in online learning. Oh et al. (2018) compared peer and instructor facilitation in online discussion, and they even found that peer facilitation was more effective in promoting cognitive presence and collaborative learning for adult learners. Therefore, we suggested that encouraging students to exercise teaching presence

is an effective way to create shared metacognition and thus help students become more active, reflective, and effective learners in an online learning community.

The third research question examined the influence of having students label their cognitive presence in online discussions. Using labels to categorize messages has been commonly used in online discussion to improve students' engagement in learning (Gao, 2014; Jeong and Joung, 2007; Jonassen and Remidez, 2002; Stegmann et al., 2004). However, our results did not find any statistically credible association between post-labeling and students' cognitive presence. The data showed that when students were asked to label cognitive presence in discussion postings, no credible change in cognitive presence was observed. So far, the literature shows that the influence of post-labeling is still not clear and mixed findings have been reported. For example, Stegmann et al. (2004) did not find any evidence that shows that labelling practices could influence students' knowledge acquisition in online discussion. Jeong and Joung's (2007) study even showed that the labeling approach impeded the process of generating critical arguments. They found that students who labeled their posting were less likely to challenge others or respond to others' challenges. At the same time, some studies found that the adoption of the labeling approach could significantly increase students' use of discussion strategies (Gao, 2014) and help students produce more justified claims (Stegmann et al., 2004). Given these findings, one possible reason for our result was that post-labeling may have both positive and negative influences on different aspects of student learning. This brought in challenges in detecting the overall influence of the labeling intervention on students' cognitive presence. Another plausible explanation was that the two activities, providing instructions on DTP techniques and asking students to label cognitive presence, occurred at the same time in the second phase of the interventions. The two might interfere with each other; thus, the influence of the later-added intervention, the practice of post-labeling, was hard to detect.

In sum, the results of this study showed that encouraging students to share metacognition and guiding them to use DTP techniques were effective in enhancing students' learning engagement in a community of inquiry. Our findings resonate with the current trends of preparing the next generation of citizens. For an increasingly interdependent society, to face the global challenges and to cope with the complexity of knowledge nowadays, merely developing personal understanding is not enough; it is essential that all the participants take on the responsibility to develop and confirm a shared understanding within the community (Garrison and Akyol, 2015). Therefore, in education, promoting students' teaching presence and fostering shared metacognition in joint knowledge construction is important not only for improving learning engagement, but also crucial for developing their citizenship for creating a supportive and productive society (Garrison, 2022).

This study has some limitations. First, the sample size was relatively small. A larger sample size can detect the effects of DTP practices more effectively. At the same time, the sample sizes were unequal for the two groups. We further divided the treatment group into two groups to control the influence of group size. Yet, the number of groups in a class may also have an effect on the dynamics of online discussion. Second, we only analyzed the online discussion to examine DTP and cognitive presence. We assume that examining multiple activities in an online course such as blogging, clinical projects, and essay writing could better reveal the complexity of DTP in online learning. Moreover, the interventions were relatively short-term, varying from 7 to 13 weeks. Longer interventions or a follow-up program could help capture more conceptual or attitude changes that only take place over prolonged periods. Last, in the second phase of this study, two interventions were implemented at the same time and this brought in challenges in detecting the influence of post-labeling. Future research will use longer interventions and more balanced sample sizes for more reliable and robust observations. We may also examine students' teach-

ing and cognitive presence in different learning activities to reveal a richer complexity of DTP and cognitive presence in online learning. Additionally, we will examine the intervention of post-labeling separately to investigate its influence on students' cognitive presence development.

6. Conclusions

Promoting shared metacognition in knowledge building is an important strategy to establish interdependence between students and to foster students' engagement in online learning (Cacciamani et al., 2021; Garrison, 2022; Kao, 2013). The study explored this strategy through applying the practices of DTP in the online learning environment. Students were guided to use relevant teaching presence techniques and were asked to label their cognitive presence in online discussion. We examined the changes in students' cognitive presence and teaching presence to reveal the influence of the interventions on students' learning engagement. The results showed that providing explicit instruction on DTP techniques significantly improved students' cognitive and teaching presence in online learning. Our data demonstrated that through exercising teaching presence, students not only helped peers improve their cognitive presence, but also helped themselves achieve a higher level of learning. Yet, the results did not find any credible evidence for the effects of post-labeling practices. Overall, the findings of this study provide important insights into how to develop DTP in online learning and how shared metacognition could help enhance the learning process and outcomes. We humbly hope that this study may contribute to future research on the design and facilitation of shared metacognitive learning experiences and thus help online educators realize the full potential of collaborative learning in online education.

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Informed Consent Statement: Written consent is not required for the exemption as the researchers did not have direct interaction with the participants. The research only used the data that already existed in the course for the purpose of course improvement.

Data Availability Statement: The data of this study cannot be shared to protect participants' privacy.

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