Investigating Cognitive Presence Patterns and Content Knowledge Levels in Asynchronous Online Discussions (AODs): A Longitudinal Study

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Abstract

Students construct knowledge during asynchronous online discussions (AODs). Discussion postings show students' cognitive presence (CP) patterns and content learning levels. The purpose of this longitudinal field observation study was to investigate the patterns of, and relationships among, the same cohort of graduate students' cognitive presence and content knowledge level demonstrated within and across the AODs in two consecutive courses over two semesters. Content analysis of online discussion postings, descriptive and correlational statistics were used to analyze data. The results indicated that the exploration was the most active phase that emerged in AODs, followed by the integration, triggering event, and resolution. There was a significant change in the integration phase of CP and content knowledge levels over time. Moreover, the results yielded significant relationships among CP patterns and content knowledge levels. The findings have important implications theoretically in confirming the CP patterns that emerged in AODs and practically by identifying the dynamics of each of the CP phases and their associations with content learning.

Keywords: Asynchronous Online Discussions; Cognitive Presence; Content Knowledge

Introduction

For decades, asynchronous online discussions (AODs) have been used as a social, collaborative learning environment in higher online education. Social constructivism views learning in such an environment as an act of constructing knowledge through socially informed cognitive engagement where participants share, debate, listen, reflect, and confirm their knowledge in the context of communicating with others (Jonassen et al., 1995; Johnson & Johnson, 1996; Vygotsky, 1978).

AODs are primarily designed to prompt learners to engage cognitively to enhance their content learning through social interactions. Current research in AODs often studies cognitive engagement using the cognitive presence (CP) construct of the Community of Inquiry (CoI) framework to examine students' learning process (Garrison et al., 2000). CP defines ways that students mentally navigate the social learning process; how they consider new problems, seek to develop understanding, and share understanding with their learning community during the process of validating and modifying their understanding (Akyol & Garrison, 2011).

In AODs, students co-construct their knowledge through iterative interactions and collaborations with others in their learning community (Hew & Cheung, 2003; Joksimovic et al., 2014). Such collaborative interactions can prompt co-regulation and metacognition among those participating in communication events, activating, and enhancing cognitive processing within the individual and across the community (Jonassen et al., 1995).

AODs can activate a student's cognitive processing beyond surface learning into deeper learning through CP (Garrison et al., 2001). "In AODs, learners who have different ideas and prior experiences share their thoughts, read, reflect on, and react to others' postings using their cognitive processes (behavior) to collaboratively create a richer understanding of the content topic at hand (learning)" (Koszalka et al., 2021, p, 3). Such interactions represent higher-order thinking (Anderson et al., 2001) and suggest behaviors that indicate the construction of deeper content knowledge (Akyol & Garrison, 2011; Garrison et al., 2001; Jonassen et al., 1995).

However, studies have shown that learning expectations for multiple CP phases and deeper content learning in AODs are not always achieved (Chen et al., 2019; Koszalka et al., 2021; Koszalka et al., 2019). Researchers have examined factors that may contribute to exploration activities during cognitive engagement processes to understand these deficiencies. But few studies were found that directly studied the relationships among cognitive presence (CP) and level of content knowledge demonstrated in AODs. Koszalka et al. (2021) recently suggested a significant relationship among levels of idea exchange, content focus, and surface/deep learning in AODs, but only studied this phenomenon in several one-time, short AOD sessions, not directly investigating CP. Since individual cognitive engagement can result in different cognitive development outcomes, e.g., levels of demonstrated content learning (Jonassen et al., 1995; Koszalka et al., 2021), it is important to unpack the relationships between CP and content learning levels. And how learners enter deep content learning during AODs with the development of CP processes and whether they maintain or build different patterns and levels of deep learning in subsequent AOD experiences are lack of study. Therefore, it is necessary for us to explore how CP presences and content learning changes over time. Such studies may inform design strategies for conducting effective AODs.

The current study focused on studying the relationships among each phase of CP (trigger, exploration, integration, resolution) and the level of content learning demonstrated within the same cohort of students, across two consecutive core courses, offered over two semesters

(longitudinal study). We hope to identify whether students who engage in various surface and deep learning strategies during AODs in an early course benefit from this initial experience and continue to engage in deeper learner behaviors in subsequent AODs. These questions suggest looking at longitudinal patterns of cognitive presence and learning levels across multiple, sequential AODs within and across courses. Therefore, the present study aims to add our understanding of the relationships between CP and depth of content learning and how these patterns form (or not) longitudinally.

Research Questions

The current study involved analyzing the AODs transcripts. We collected the convenient data from the same cohort of 12 graduate students from two courses. These students were pursuing a master's degree in instructional design. Before taking the two courses, all students have had experience in online courses. IRB exempt status was granted for this study. Female and male students were 2 (16.7%) and 10 (83.3%), respectively. The average age of the cohort is 44. All participants have military experience. The average length of their military service is 22 years. Two of them are veterans, and the rest of them are active-duty service members.

Students' CP patterns were coded and examined using Garrison et al.'s (2000) CoI framework. Content knowledge levels were identified and analyzed using Anderson et al.'s (2001) updated version of Bloom's taxonomy and previously developed protocols from Koszalka et al. (2021). There were three research questions:

1. What patterns of cognitive presence and content knowledge levels emerge within and across the AODs?
2. How do the cognitive presence patterns and content knowledge levels of the same cohort of students change (or not) over time in the two courses investigated?
3. Is there any significant relationship between cognitive presence patterns and content knowledge levels of the same cohort of students across multiple AODs?

Method

The transcripts of 276 postings from Course A and 273 postings from Course B were retrieved from the Blackboard LMS, downloaded, cleaned, and saved in the qualitative data analysis software MAXQDA before coding. There was no information related to students' identities. The cohort of students participated in the AOD of Course A in the fall semester and then participated in the AOD of Course B in the spring semester of the same academic year.

We applied a quantitative content analysis approach, transferring students' postings into quantifiable codes. We followed the steps of a content analysis suggested by Neuendorf (2017, P. 67-69):

Step 1. We collected data that fit our research purpose

Step 2. We selected a single meaning as the unit of analysis.

Step 3. The two coders in our team independently divided each posting into one meaning and then dismissed the inconsistencies through a discussion.

Step 4. The two coders coded the meanings with two separate existing coding frameworks. The first is cognitive presence from Garrison et al. (2001), and the second is content level from Koszalka et al. (2021). The first four categories of the coding framework focused on

the cognitive engagement process in the course content. The last two categories focused on the level of content learning (surface or deep) demonstrated in students' postings.

Step 5. The two coders coded the first 200 meanings of the AODs for checking the inter-rater reliability.

Step 6. The two coders discussed the inconsistencies, re-coded the 200 meanings to improve inter-rater reliability, and finished coding the rest of the meanings in the AODs.

Finally, relying on the numerical data in terms of the codes, we run descriptive and correlational statistics through the SPSS software for finding the patterns (RQ1), changes (RQ2), and relationships (RQ3).

Results

RQ1. What patterns of cognitive presence and content level emerge within and across the AODs?

Descriptive statistics were generated to understand the patterns. Through the content analysis, we produced 1630 meanings (n=1630) hidden in the postings of the AODs.

While all the four phases of cognitive presence appeared in the meanings, the ratios of their frequencies were different. The exploration phase was identified from 1382 meanings out of 1630, having the highest ratio (84.8%) among the four phrases. The integration phrase took second place with 349 meanings. Only 152 and 51 meanings correspondingly include the triggering event phrase and the resolution phrase.

The proportions of the content levels are only slightly different compared to the proportions of CP. 947 meanings were coded as content low, while 664 meanings were coded as content high. Only 19 meanings existed for social purposes and did not have any content relating to the discussion topics.

RQ2. How do the cognitive presence patterns and content knowledge levels of the same cohort of students change (or not) over time in the two courses investigated?

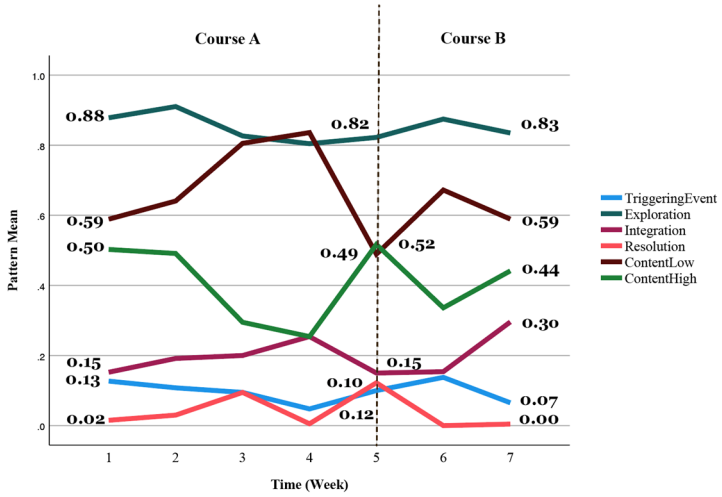
To better understand whether and how the cohort's patterns change over time in the two courses, we also coded each meaning of the AODs with the posted week as a time label. The AOD in Course A lasted five weeks, and the AOD in Course B lasted two weeks. The number of generated meanings from Week 1 to Week 7 are 197, 167, 190, 189, 180, 247, and 460. These numbers clearly demonstrated a tendency for the same cohort of students to become more engaged in the last two weeks as they created more meanings.

Figure 1 shows the changes in the CP and content level in the AODs over time. When we observed the changes from a seven-week range, both the cognitive presence and content level fluctuated over time and thus did not show a consistent tendency. With low mean values, both the triggering event and resolution phrases are stated at low mean values and fluctuate less than other phrases. This indicated that students rarely played as an ice breaker (i.e., the role triggering a new topic) and problem-solver (i.e., the role posing a solution to a problem) in any time spot of their AODs. Comparatively, the mean value of the exploration phrase stayed high all the time, implying that students were more likely to play the explorer (i.e., the role providing pieces of content) and stick to this role during the whole AOD process. The tendency of the integration phrase fluctuated less in the first five weeks, but it showed a sudden increase in the last two weeks. This could suggest that after finishing the AODs of Course A, the cohort of the students

promoted their ability to integrate pieces of information into a whole new meaning unit as they were more willing to play the role of synthesizer.

The tendencies of content level fluctuated more fiercely compared to the cognitive presence tendencies. We were surprised that the two tendency lines of the content low and content high were highly symmetrical and even looked like mirror effects. It implied a strong correlation effect between the content low and the content high. In the weeks of Course A, the content low tendency was leveling up in the first three weeks, peaked in the fourth week, and then fell sharply in the last week. Oppositely, the content high tendency was leveling down in the first weeks, reached a valley in the fourth week, and then went back to the situation close to the start point.

Figure 1. AOD Patterns Over Time



RQ3. Is there any significant relationship between cognitive presence patterns and content knowledge levels of the same cohort of students across multiple AODs?

Inferential statistics were generated for understanding the relationships among the cognitive presence phrases and content knowledge levels. The matrix below (Table 1) shows the significant correlations. The content high variable was strongly and significantly correlated with the content low variable negatively ($r=-.836$, $p<0.01$). It could indicate that students rarely invested their endeavors in creating meaning with both content levels in the AODs. Another strong and significant correlation occurred between the exploration and integration phase variables ($r=-.674$, $p<0.01$). It revealed that the exploration phrase and integration phrase hardly co-existed in a single meaning of the AODs. In other words, students tended to stay with either a deductive phase (i.e., exploration) or an inductive phase (i.e., integration) rather than involve both when they created an AOD meaning.

Some correlations were found comparatively weak but significant. It seems that the resolution phase of CP was slightly correlated with the content low variable negatively ($r=-0.09$, $p<0.01$), but it was slightly correlated with the content high variable positively ($r=0.081$, $p<0.01$). It suggested that in the resolution phase, students preferred to stay at the content high level. The exploration phase variable was positively correlated with the content high variable ($r=0.08$, $p<0.01$). It suggested that when students explore information for building the meanings of the AODs, they tend to use the content with their higher levels of thinking (e.g., analogy, comparison).

Regarding the time variable, the data ($r=-0.056$, $p<0.05$) indicated that content level might increase as time went on. Furthermore, students seemed to become more cognitively engaged in the integration phase ($r=0.083$, $p<0.01$) and less cognitively engaged in the resolution phase ($r=-0.063$, $p<0.05$) when the AODs were closer to the end.

Table 1. Correlation Matrix for All the Patterns

		ContentLow	ContentHigh	TriggeringEvent	Integration	Exploration	Resolution	Time
ContentLow	Pearson Correlation	1	-.836**	-.034	-.021	-.007	-.090**	-.056*
	Sig. (2-tailed)		.000	.166	.394	.786	<.001	.025
	N	1630	1630	1630	1630	1630	1630	1630
ContentHigh	Pearson Correlation	-.836**	1	.005	.012	.080**	.081**	-.018
	Sig. (2-tailed)	.000		.851	.638	.001	.001	.456
	N	1630	1630	1630	1630	1630	1630	1630
TriggeringEvent	Pearson Correlation	-.034	.005	1	-.044	-.046	-.046	-.040
	Sig. (2-tailed)	.166	.851		.076	.062	.066	.105
	N	1630	1630	1630	1630	1630	1630	1630
Integration	Pearson Correlation	-.021	.012	-.044	1	-.674**	-.016	.083**
	Sig. (2-tailed)	.394	.638	.076		<.001	.506	<.001
	N	1630	1630	1630	1630	1630	1630	1630
Exploration	Pearson Correlation	-.007	.080**	-.046	-.674**	1	-.071**	-.035
	Sig. (2-tailed)	.786	.001	.062	<.001		.004	.153
	N	1630	1630	1630	1630	1630	1630	1630
Resolution	Pearson Correlation	-.090**	.081**	-.046	-.016	-.071**	1	-.063*
	Sig. (2-tailed)	<.001	.001	.066	.506	.004		.010
	N	1630	1630	1630	1630	1630	1630	1630
Time	Pearson Correlation	-.056*	-.018	-.040	.083**	-.035	-.063*	1
	Sig. (2-tailed)	.025	.456	.105	<.001	.153	.010	
	N	1630	1630	1630	1630	1630	1630	1630

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

Our analysis of the first research question suggested that the exploration phase was the most active in AODs, followed by the integration, triggering event, and resolution. The highest ratio of exploration frequencies and the lowest ratio of resolution frequencies in AODs is consistent with previous research (Chen et al., 2019; Garrison et al., 2001; Meyer, 2003; Vaughan & Garrison, 2005). Some previous studies pointed out that it was difficult for students to reach the integration phase (Akyol & Garrison, 2008; Garrison, 2007; Kanuka et al., 2007; Vaughan & Garrison, 2005), but in this study, the integration phase is the second most active phase emerged in AODs. This finding aligns with Akyol and Garrison's (2011) study, revealing that the integration phase is active (Akyol & Garrison, 2011). The different results on cognitive presence patterns that emerged in AODs might be explained by different instructional designs of courses, including types of prompt questions (Chen et al., 2019; Garrison, 2007) and duration of AODs. The prompt questions for causes seeking and problem-solving are more likely to facilitate students to connect and synthesize ideas to construct their meanings and provide solutions, that is, to reach the integration and resolution phase of cognitive presence. The length of AODs also can affect students to achieve the integration and resolution phase. The longer students participated in AODs, the higher the possibility of reaching the integration and resolution phase. As for the content knowledge levels, the previous study, which explored the evidence of student content learning levels in a single course, showed that students' content-low postings were dominant in AODs (Koszalka et al., 2021), which is consistent with our study.

Our analysis of the second research question suggested that both cognitive presence patterns and content knowledge levels could change over time. Among the cognitive presence patterns, integration and resolution phases fluctuate a lot more than the other phases. Both the triggering event and exploration were at the highest levels at the beginning of the course weeks, and then there was a decreasing trend, finally going back to a higher level during the late weeks. Both the integration and resolution reached the highest levels during the mid and late course weeks and then presented a decreasing trend. These findings highly align with Sezgin's (2020) study. However, Sezgin (2020) conducted their study only in a single seven-week online course. Since this longitudinal study focused on changes over time in two courses across two semesters, something unique we found about the changes was that integration was the only phase of cognitive presence increased in the second course, which might be explained by the type of discussion questions and time. Students are more likely to reach the integration phase with more structured questions, and they can better integrate ideas from different sources with practice and efforts through AODs (Akyol & Garrison, 2008; Sezgin, 2020). For the content knowledge levels, we found that there were more content-low postings during the early weeks in which students tended to focus on sharing facts, a summary of reading materials, and their general understanding of the discussion topics. As time goes by, students gradually connect their understanding of the discussion topics with their personal experiences to demonstrate higher-order thinking skills.

Our analysis of the third research question suggested the correlations between cognitive presence patterns and content knowledge levels. Such correlations may enlighten the instructional design of AOD in multiple aspects. First, the negative correlation between the content low variable and content high variable indicates that students tend to stay at a single content level (i.e., low or high) when constructing an independent meaning in the AOD. The correlation between the exploration and integration phases demonstrates a similar pattern: students focus on only one cognitive presence phrase when they construct meaning. Therefore, the instructors may need to require or encourage students to construct multiple meanings in a posting so that multiple content levels and phrases of cognitive presence can occur in the AOD. A tested instructional approach to making this happen is to design structured prompts for eliciting diverse meanings in a single posting (Darabi et al., 2013). Structured prompts often include sequential questions requiring students' responses in different cognitive or content levels (Darabi et al., 2011). A group of researchers has found that structured prompts would lead to the robustness of meanings with various cognitive learning indicators in the AODs (Darabi et al, 2011; DeNoyelles et al., 2014; Lee 2012). Second, both the exploration phrase and resolution phrase were significantly correlated with the content high variable. It suggests that if students are expected to engage in the AODs cognitively, they may need to equip their high-level content learning skills, such as comparing different concepts and creating real examples. The study conducted by Koszalka et al. (2021) involved a series of pre-work activities prior to the AODs. In the pre-work activities, students had the chance to read the assigned content and practice their high-level content learning skills by reflecting on some scaffolded questions. The result proved that students were more cognitively engaged in the AOD after taking the pre-work activities. Thus, preparing students for some high-level content learning skills in advance can benefit students' cognitive presence in the AOD.

Conclusion

The research findings indicate that the exploration was the most active phase in AODs, followed by the integration, triggering event, and resolution. There was a significant change in the integration phase of CP and content knowledge levels over time. Moreover, the results yielded significant relationships among CP patterns and content knowledge levels. To encourage multiple CP phases and achieve deeper content levels in AODs, the instructors may need to require students to construct multiple meanings in a posting. For example, provide specific participation guidelines, design a timely feedback system, use structured prompts to elicit diverse meanings, or prepare students some high-level content learning skills in advance through well-designed pre-work activities. Future research may include but is not limited to the following list of potential empirical research: 1) Collect discussion transcripts in a longer time range (e.g., five years) to examine students' CP patterns and content learning levels demonstrated in AODs; 2) Compare the CP patterns and content learning levels of military students with non-military students to examine if students' characteristics influence their performance; 3) Integrate self-reported surveys and interviews to triangulate the findings of content analysis.

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