Chapter

4

The Community of Inquiry perspective on students' social presence, cognitive presence, and academic performance in online project-based learning

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Abstract

Project-based learning engages students in knowledge acquisition, application, and construction through artifact development. Based on the Community of Inquiry framework, this study characterized college students' social and cognitive presences in online project-based learning and examined how presence was related to their academic performance. Twenty-four groups of students participated in a three-week project via WeChat discussion groups and created a final product. Transcripts of students' online discourse were collected and analyzed by a coding scheme. The quality of students' artifacts was evaluated by a grading rubric. Descriptive results showed that the component of affectiveness and the level of exploration accounted for the majority of students' social and cognitive presences, respectively. Stepwise regression analyses revealed that certain components and sub-components of students' social presence and levels and sub-levels of their cognitive presence were positively associated with their academic performance. Practical implications for teachers and suggestions for further research are provided.

Keywords: Online project-based learning; Community of Inquiry; Social presence; Cognitive presence; Academic performance

4.1 Introduction

Project-based learning (PjBL) indicates an inquiry-based teaching and learning method that engages students in knowledge acquisition, application, and construction through the completion of authentic projects and the creation of real-world artifacts (Krajcik & Shin, 2014; J. W. Thomas, 2000). Chen and Yang (2019) confirmed in their meta-analysis research that PjBL could be considered as an alternative pedagogy to traditional, teacher-centered instruction in primary, secondary, and tertiary education. Guo et al. (2020) also revealed that PjBL, as a promising approach in higher education, is positively related to student cognitive, affective, and behavioral learning outcomes. During PjBL learners usually work in small groups and collaboratively explore projects with peers (Chen & Yang, 2019; Dado & Bodemer, 2017). In order to facilitate learners to involve in this learning process, it might be helpful to adopt computer-supported technologies (W. R. Thomas & McGregor, 2005). Previous studies have mainly investigated student social and cognitive presences in online PjBL with computer-supported systems and tools under the guidance of different theories and models (e.g. Heo et al., 2010; Koh et al., 2010; Lin et al., 2013; Wu et al., 2013; Wu & Hou, 2014). To investigate students' social presence, Heo et al. (2010) and Wu et al. (2013) adopted the Interaction Analysis Model (IAM) proposed by Gunawardena et al. (1997). To explore students' cognitive presences, Lin et al. (2013), Wu et al. (2013), and Wu and Hou (2014) used the Revised Bloom's Taxonomy (RBT) by L. W. Anderson and Krathwohl (2001). Koh et al. (2010) analyzed both students' social and cognitive presences based on the Community of Inquiry (CoI) framework (Garrison et al., 2000). Still, few empirical data are available about students' social and cognitive presences during online PjBL and how these presences affect the quality of the final products students develop.

Some studies about students' online interaction in higher education have claimed that knowledge construction can occur through the social and cognitive exchanges of ideas in learners' online discourse (Agudo-Peregrina et al., 2014; Garrison et al., 2001). Studies that are based on the CoI framework have shown that both lower levels (e.g. Meyer, 2003; Shea et al., 2010; Vaughan & Garrison,

2005) and higher levels (e.g. Gašević et al., 2015; Oh et al., 2018; Richardson & Ice, 2010) of cognitive presence are most common in online discourse. These findings might be related to the structure of the problem that students face. Gašević et al. (2015) claimed that learners can achieve higher levels of cognitive presence during online discussions if they work on well-structured rather than ill-structured tasks. However, Koh et al. (2010) found that compared to non-project-based activities, during online PjBL, which is usually ill-structured, students' posts could be reaching more advanced cognitive presence. Moreover, although social presence is critical to the understanding of students' online discussions (Shea et al., 2010), few studies have investigated it (e.g. Richardson & Ice, 2010; Vaughan & Garrison, 2005) or examined it in general (e.g. Galikyan & Admiraal, 2019; Li & Yu, 2020; Meyer, 2003). Furthermore, Picciano (2002) claimed that social presence is more significant when it comes to learning activities that are not just about acquiring knowledge but also constructing new information with peers.

In this study, we aim to characterize students' social and cognitive presences in online discussions during PjBL and investigate how they are related to student performance. The findings might help learners to effectively engage in online PjBL and contribute to the enhancement of students' knowledge acquisition, application, and construction.

4.2 Students' social and cognitive presences in online discussions

4.2.1 Community of Inquiry framework

An important theoretical framework to understand and promote students' online learning in higher education, particularly the social and cognitive learning processes (Shea et al., 2005) is the CoI framework (Garrison et al., 2000; Garrison & Arbaugh, 2007). This framework addresses the social and cognitive nature of student presence in knowledge construction (Cheung et al., 2020). It contains three essential aspects, namely social, cognitive, and teaching

presences. Social presence refers to online learners' ability to interact socially and emotionally with other participants and see them as "real" people in a community of inquiry through the means of communication used (Garrison et al., 2000). More specifically, social presence consists of three components (Rourke et al., 2001): 1) affectiveness, where learners express conventional and unconventional emotions, 2) open communication, where students respond to others and others' contributions, and 3) group cohesion, where group members build and sustain a sense of group commitment. Cognitive presence is defined as the extent to which "learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry" (Garrison et al., 2001, p. 11), and contains four levels (Garrison & Arbaugh, 2007): 1) triggering event —the initial identification of issues for further inquiry, 2) exploration —the investigation of issues collaboratively via critical discourse, 3) integration —the construction of meaning based on the idea exchanged in the exploration phase, and 4) resolution —the solution to dilemmas or issues by direct or indirect actions. Garrison et al. (2000, 2001) claimed that the latter phase represents a more advanced cognitive level than the previous phase. Teaching presence 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" (T. Anderson et al., 2001, p. 5). Teaching presence includes three components (Akyol & Garrison, 2008; T. Anderson et al., 2001): 1) instructional design and organization, such as setting curriculum and building time parameters, 2) facilitating discourse, such as identifying areas of agreement/disagreement and seeking to reach consensus, and 3) direct instruction, such as presenting questions and confirming understanding. Teaching presence in the course implemented in this study was common and stable. We provided information about teaching presence as part of the course description and the research context (see Section 4.3.1), instead of a measured variable as this study focuses on students' social and cognitive presences in PjBL.

4.2.2 Levels of social and cognitive presences in online discussions

A number of studies have investigated learners' social and cognitive presences through the lens of CoI framework via the content analysis of students' online discourse (e.g. Rourke et al., 2001; Shea et al., 2010; Swan, 2002; Swan & Shih, 2005). Regarding social presence, for example, Kilis and Yildirim (2019) examined students' online posts of six discussion activities about their understanding of content knowledge and perceptions of using computers. The authors showed that most students' posts lied at the component of affectiveness and open communication rather than group cohesion. Li and Yu (2020) examined both students' initial posts to answer the questions proposed by teachers and their replies to other students. The authors showed that in terms of social presence, learners mainly shared emotions, had off-topic talks, and acknowledged each other. In the study of Evans et al. (2020), the discourse of online instructors instead of students in interprofessional education was analyzed on how they assisted students' knowledge construction. Their findings revealed that online instructors used many indicators of open communication, such as responding to students and parsing students, and group cohesion indicators, such as referring to students by name and pure social communication. However, they barely used affective indicators in their posts. Kaul et al. (2018) confirmed this. They hardly found in-service teachers' affective posts from their reflection on how to connect their teaching practice to the course materials. In the study of Galikyan and Admiraal (2019), student teachers' overall social presence during online discussions, such as greetings and social sharing, was investigated. It turned out that only 12% of the first-year students' and 3% of the second-year students' discourse was coded as social presence. Yet, sub-indicators of social presence were not coded.

As for students' online cognitive presence, in some studies, learners' online discussions remained in the beginning cognitive phases, namely triggering event and exploration (e.g. Garrison et al., 2001; Shea et al., 2010; Vaughan & Garrison, 2005). For example, Jo et al. (2017) analyzed undergraduate students' online discussions about the course topic for 12 weeks and found that 60% of students' posts were about exploration and no messages were coded at the

resolution level. In the study of Kilis and Yildirim (2019), students who took an ICT course participated in six online discussion activities relevant to the course topic for 12 weeks. Students' posts were coded at one or multiple levels of cognitive presence at the same time. For example, a post can be coded at the level of triggering event or both triggering event and exploration simultaneously. The authors calculated the average percent of students' posts at each cognitive level in all discussion activities. The results showed that the level of triggering event and exploration accounted for 55% and 72% of students' posts, respectively. In some studies, a higher level of cognitive presence (i.e. integration) was frequently found in students' discussions (e.g. Akyol & Garrison, 2011; Meyer, 2003; Richardson & Ice, 2010). For example, Oh et al. (2018) investigated students' online debate about a moral dilemma. The coding results showed that more than half of students' messages were in the integration phase. In the study of Galikyan and Admiraal (2019), more than 40% of student teachers' posts contributed to the integration level in both groups of first and second year students. However, a number of studies have revealed that the most advanced level of cognitive presence (i.e. resolution) was barely found in students' online discussions (e.g. Galikyan & Admiraal, 2019; Gašević et al., 2015; Kaul et al., 2018; Meyer, 2003; Vaughan & Garrison, 2005). For example, Richardson and Ice (2010) investigated students' critical thinking levels in three types of instructional strategies, namely case-based discussions, debate, and topic-based discussions. The coding results of students' online discussions showed that the proportion of the resolution phase, such as testing and defending solutions, were under 3% in all contexts. These different results of the cognitive level might be related to the duration of online discussions (Richardson & Ice, 2010), the design of the discussion problem and the discussion strategy (Darabi et al., 2011), and whether teachers provide guidance for students and ask good questions (Berge & Muillenberg, 2002 in Bender, 2003, p. 69).

4.2.3 Relationship between academic performance and social and cognitive presences

Some studies have investigated how student online social and cognitive presences are related to their academic performance (e.g. Kim, 2014; S. Y. Liu et al., 2009; Yoo & Kim, 2012). With regard to social presence, for example, Picciano (2002) investigated the relationship between online learners' social presence and academic performance. During the course, students had a number of discussions related to course topics. They were asked to write a report for a case study and had an exam about the content knowledge. Correlational analyses revealed that students' perceived social presence was significantly and positively related to the performance of the written assignment rather than the knowledge test. Dixson et al. (2006) investigated the relationship between the quality of students' discussions about analysing certain scenarios and their online interactions. It was found that the more information students shared with each other, the better decisions they would make. Moreover, better decisions were also positively related to group solidarity. Williams et al. (2006) examined how students' teamwork values are related to perceived learning benefits in online MBA programs. During the courses, learners had extensive discussions and analyses about certain cases with their team members. Survey results revealed that group cohesiveness and teamwork orientation predicted both students' overall learning and team-source learning. Joksimović et al. (2015) explored the association between graduate students' social presence in two-week online discussions and the course grade. In the discussions, students mainly commented on others' presentations, connected the course materials to the presentations, and provided ideas to improve that. The course grade consisted of both students' participation in the discussions and the quality of their discussions. Multiple regression analyses revealed that two indicators of open communication, i.e. continuing a thread and expressing compliments were positively and negatively related to students' final grade, respectively. These findings suggest that various aspects of students' social presence can be related to academic performance.

In terms of cognitive presence, Galikyan and Admiraal (2019) explored the relationship between student-teachers' cognitive presence in online discussion and their academic performance. In the online discussion forum, students were asked to reflect on the course materials and connect these to their teaching practice and provide solutions to practical teaching problems. Bloom's Taxonomy was used as a guideline for students to formulate and answer questions. Multiple regression analyses showed that—although the resolution level accounted for a tiny amount of cognitive presence—both integration and resolution were significantly related to student final grades. In another study, Jo et al. (2017) coded students' online posts based on the four levels of cognitive presence and calculated the overall score by giving weight to each level and divided by the total number of posts. The results of the regression analysis revealed that the overall cognitive presence is significantly related to student academic performance. In short, the available studies suggest that student cognitive presence might have influence on academic performance.

4.2.4 Research questions

While the current study also focused on students' social and cognitive presences in online discussions, it is different from the previous research. In the previous studies, students were usually provided with questions for discussion by the teacher. These questions normally were clear and well-structured and can be discussed directly (e.g. Evans et al., 2020; Galikyan & Admiraal, 2019; Joksimović et al., 2015; Kaul et al., 2018; Oh et al., 2018, p.; Richardson & Ice, 2010). Moreover, students could follow certain rules, guidelines, and steps to participate in the discourse (e.g. Kim, 2014) and use the sample template to write essays (e.g. Jo et al., 2017). Thus, these discussion activities were more like problem-solving instead of knowledge construction. Furthermore, some debate-based questions might naturally lead to a higher level of cognition of students (e.g. Oh et al., 2018; Richardson & Ice, 2010) due to its equivocal nature (C.-J. Liu & Yang, 2012). This may limit the capture of the lower level of students' cognitive presence. In the present study, however, students were engaged in PjBL which the most important feature is the construction of new knowledge

through the creation of artifacts. During this process, students usually face a series of ill-structured and open questions. This first means that students cannot directly discuss certain problems and give solutions before they collaboratively break down and refine the driving question into multiple sub-questions. In addition, there are usually no ready-made samples for students to use, and therefore, they need to discuss and decide what theories and frameworks to be adopted, how to collect and analyze relevant data, and what types of carrier, i.e. physical objects, documents, and multimedia to be used to present the artifact and how to present the results in a good way (Guo et al., 2020). Since during this process students engage in various explorative activities, a comprehensive picture of their cognitive presence could be presented. Furthermore, regarding the relation between students' social and cognitive presences and academic performance, previous studies either did not investigate it (e.g. Kilis & Yildirim, 2019; Li & Yu, 2020; Shea et al., 2010) or examined the relation based on only some components of social and cognitive presences (e.g. Galikyan & Admiraal, 2019; Jo et al., 2017; Williams et al., 2006). This study will address this gap via the analysis of the potential impact of all components and sub-components of social and cognitive presences on students' academic performance.

The current study is about students' social and cognitive presences and their relationship with students' academic performance in online PjBL. Despite that creating artifacts plays the most distinguishing role in PjBL (Blumenfeld et al., 1991; Helle et al., 2006) as artifacts are the representation of the performance of students' knowledge application and construction in PjBL, few studies of PjBL in higher education, according to Guo et al. (2020), have evaluated the performance of students' final products. For example, in the studies of Chua (2014) and Chua et al. (2014), students participated in an engineering project and created small dryers for an agricultural client. The quality of the dryer was assessed by a 5-point scoring rubric based on a series of components, such as drying time and product quality. In Papastergiou (2005), student-teachers participated in an educational project and built websites for primary schools as the artifacts. The performance of these websites was evaluated based on five groups of parameters, such as pedagogical, technical, and usability variables.

The quality of students' group artifacts was evaluated as student academic performance in this study. Since students created artifacts in small groups, we focused on the relationship at the group level. Thus, the specific research questions are as follows:

1. What components of social presence describe student groups' artifact creation in online discussions?
2. What levels of cognitive presence describe student groups' artifact creation in online discussions?
3. How is student social presence in online discussions related to the artifact performance?
4. How is student cognitive presence in online discussions related to the artifact performance?

4.3 Method

4.3.1 Research context and sample

This study was based on an 8-week online course of the Introductory Course of Mental Health for the freshmen in a Chinese university (as the course implemented in the study in Chapter 3). There were two classes (in total 90 mins) per week. In the first class of the first week, the course teacher introduced students to the course structure and some basic course requirements (e.g. course check-in). The primary researcher introduced students to the idea, the ethical rules of this study and the PjBL pedagogy and encouraged them to participate in this study. In addition, the researcher and the teacher introduced students to the film analysis project adopted in this course. This project aimed to help students better acquire and apply the content knowledge and eventually construct new information via the creation of a film analysis report. They also provided students with the grading criteria for the report and some suggested steps to complete the report, such as to first form small groups and create private WeChat groups, to select the film to be analyzed and the theory to be used, and to discuss how to write each part based on the grading criteria.

Afterwards, for students, in the first to the third week, they were required to watch 26 recorded instruction videos in 6 chapters on the MOOC platform of the university. These videos contained basic content knowledge that students needed to learn and they were free to choose the watching sequence. They also needed to complete the quizzes in each chapter and asked questions to other students and the teacher and had discussions on these questions. Meanwhile, students participated in the film analysis project and created an artifact (i.e. a film analysis report) in small groups. To this end, students were first asked to watch four films provided and choose one of them for further analysis. Since the aim of this course was not about professional film analysis, students did not analyze the entire film. They only needed to select certain excerpts of that film and analyze them based on the topics and theories that they learned from the online videos. During the whole process, students were asked to discuss everything about the project in their WeChat groups. The teacher mainly reminded students to log in the course every week and answered students' questions about the videos on the MOOC platform.

In weeks four to seven, the teacher gave online lectures and students attended these lectures. Students took a final paper-pencil exam in the last week. In total, 24 small groups of 3 to 4 students (M_{age} = 19) discussed and wrote the film report. These procedures observed the ethical requirements for educational research. All participants provided consent.

4.3.2 Data sources

Transcripts of students' messages during the online discussions for the group activity in the 24 WeChat groups were coded regarding social and cognitive presences. Five types of messages were identified, namely text messages, stickers and emojis, uploaded pictures and documents, audio messages, and audio calls. Audio messages were transferred into text messages for the coding and audio calls were excluded for the analysis because no recordings could be reached. Six groups had audio calls to discuss the task.

Since many messages posted were short and incomplete in meaning, in some cases, several messages were first combined to get a complete unit of meaning

and then coded. In other cases, a single message was used as the unit of coding. In either case, the guiding principle is to code the units that contained "a single concept, expression or statement" as Strijbos et al. (2006) suggested (p. 37). In total, 8469 units were coded.

Furthermore, the total number of words in each group were calculated (M = 3162.63, SD = 2936.85), including both text words and non-text words. The proportion of the non-text words of each group are under 5.5% (M = 3.4; SD = 1.3). The performance of the film analysis report was evaluated by two raters based on a grading rubric to measure the artifact performance.

4.3.3 Data Analyses

Social and cognitive presences

An adapted coding scheme with examples (See Table 4.1 and Table 4.2) based on the instrument in Shea et al. (2010) was adopted to code all units regarding social presence and cognitive presence. Three components of social presence and their corresponding sub-components were distinguished: 1) affectiveness with five sub-components, 2) open communication with six sub-components, and 3) group cohesion with five sub-components. Four levels of cognitive presence and their corresponding sub-levels were distinguished: 1) Triggering event with two sub-levels, 2) Exploration with four sub-levels, 3) integration with four sub-levels, and 4) Resolution with two sub-levels. If a coding unit contained more than one type of message, such as stickers with text on it and text followed by emojis, all types of messages were coded separately.

The coding was performed by the first and the third author. Both coders first separately studied the original coding scheme and coded three groups of discourse. After the discussion about each other's codes, the two coders modified the original coding scheme and coded the rest groups of discussions together. A final check was conducted by the first coder.

Artifact performance

The performance of the film analysis report was evaluated by the first and the third author based on a grading rubric. This rubric included criteria concerning

the structures required and the quality. More specifically, the final report grades consisted of weighted scores from three parts, namely content (70%), structure (20%), and semantics (10%). The sub-categories of the content included 16 items, such as "no less than 2500 words", "the introduction is clear", and "clear introduction of subject knowledge". Both structure and semantics had one item. Moreover, if the two raters agreed that there was additional information for extra points, for example, in-text illustrations were adopted, one extra point would be given. A 4-point rubric from 1 (not corresponds) to 4 (corresponds) was adopted. This means that scores for each report could range from 16 to 64 based on the rubric, with some additional points if applicable.

The two evaluators first separately evaluated three groups of the report and checked each other's scores for all items. Since there are only 4 levels of the score for each item, if the difference of the score of an item given by the two evaluators is greater than 1 point, such as 4 points and 2 points, they discussed this difference and each other's grading criteria and re-scored this item together. Afterwards, they separately evaluated the rest groups of the report and repeated the above-mentioned procedures until all reports were evaluated, checked, discussed, and re-scored if necessary.

Table 4.1. *Coding scheme for social presence with the component of affectiveness (AF), open communication (OC), and group cohesion (CH)*

Code	Indicators	Definition	Examples from this study
AF1	Expressing emotions	Conventional expressions of emotion.	Haha or Hahaha I'm sorry (for) Thank you (for your work) Sigh (for)
AF2	Use of humor	Teasing, cajoling, irony, understatements, and sarcasm, etc.	The love movie is not appropriate for me Open for business Summon Shenlong (the Chinese mythological dragon) You are a movie-watching master (The text on the sticker): Heart-thief, uninvited
AF3	Self-disclo-sure	Presents details of life outside of class. Expressing vulnerability; includes expressions of likes, dislikes, and preferences.	My high school teacher said that my writing had no focus but only fragmented things (The writing) is so difficult, so difficult Why didn't I find the clip I like? I wrote badly I'm confused I might be a fake leader I want to praise this movie again. It's great The scene of the last film is really beautiful
AF4	Unconven-tional expressions of emotion	Includes emoticons, emojis, stickers, repetitious punctuation, repetitious phrases, conspicuous capitalization, etc†.	Emojis and stickers Hahahahaha (more than three "ha")
AF5	Expressing value	Expressing personal values, beliefs, and attitude.	I respect the diversity Words containing life (It is) the power of the team

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Table 4.1. *(continued)*

Code	Indicators	Definition	Examples from this study
OC1	Continuing a thread	Reply to others' messages with or without quoting (software dependent) rather than starting a new thread.	(Reply to others) your seven o'clock is different from ours.
		The meaningless responses to others' messages in order to make the discussion going†.	is it ? Emm… Err… Go ahead then (what) ?
OC2	Referring explicitly to others' messages.	Direct references to contents of others' posts.	You said you chose f, right Earlier you suggested one writing direction was…
OC3	Asking questions	Students ask questions of other students or the moderator.	How long do you think you can finish watching the film? Do you mean that my introduction could be a bit shorter? Is the title good? What should I do? Revise or delete it?
OC4	Expressing compliment and appreciation	Complementing others or the contents of others' messages.	You worked really hard. Outstanding. You are so efficient.
OC5	Expressing agreement/ disagreement	Expressing echoes that similar situations/problems encountered or not.	I have encountered the same situation. I haven't encountered the same situation. I have similar problems. I want to ask as well. Me, too. +1
OC6	Personal advice	Offering specific advice to classmates.	You can watch the film on other apps. You can check it in your Recycle Bin of your computer. Don't forget to do the course exercises.
CH1	Vocatives	Addressing or referring to the participants by name.	@ Yingying Yingying, what do you think?

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Table 4.1. *(continued)*

Code	Indicators	Definition	Examples from this study
CH2	Addresses or refers to the group using inclusive	Addresses the group as we., us, our, group.	We should watch the same film, don't we? Is it okay that our group discuss the assignment tonight at 10 o'clock?
CH3	Phatics, salutations and greetings	Communication that serves a purely social function; greetings or closures.	Have an early rest and good night. Hi, my friends. Here I am.
CH4	Social sharing	Sharing information unrelated to the course.	We have a lot of homework from the other course. Sorry to cut in, but what is our English homework? The singing competition is coming soon.
CH5	Course reflection	Reflection on the course itself.	A good example was the CD-ROM we read about‡

Note: † Extension or revision of the original coding scheme; ‡ The example from the original coding scheme;

Table 4.2. *Coding scheme for cognitive presence with the level of triggering event (TE), exploration (EX), integration (IN), and resolution (RE).*

Code	Indicators	Definition	Examples from this study
TE1	Recognize problem	Presenting background information that may culminate in a question or presents a problem/ issues.	(According to the project requirements) it seems it's better to analyze excerpts.
TE2	Sense of puzzlement	Asking questions or messages that take discussion in a new direction.	Okay, let's start with the introduction. I suddenly realized that we need to submit it next week. So, what else to discuss? (after a deviation from the discussion) End of this topic. Let's divide the work.
EX1	Exploration within the online community	Unsubstantiated agreement or disagreement/ contradiction of previous ideas; includes "good point" or "I agree" with or without unsubstantiated elaboration.	Ok/yes/no problem etc. I think it's good. Good rationales. Yes, we have to point it out. She indeed introduced too much about the film itself.

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Table 4.2. *(continued)*

Code	Indicators	Definition	Examples from this study
EX2	Information exchange	External facts, such as sources from websites and articles, and information and descriptions from teachers, peer students, and the course/task requirement†.	I saw the content knowledge related to "hairstyle" in a certain course video. The teacher said in the public group that we could attach pictures. The clip that I chose is from min 24 to 70. The documents of course and task requirement.
		The information about task progress†.	I haven't finished writing yet. We can submit it by today. I'll watch the film tomorrow. I haven't watched the course videos yet.
		The information about task selection†.	I choose the clip when she first moved. I want to watch that animated film. I vote on that animated film. I choose that Japanese film. Part A is for Yingying, part B is for Jingjing, and part C is for Rui.
		Re-presenting previous information in order to make the discussion going clearly†.	Re-presenting the title of the report that was discussed before. Re-uploading the manuscript that was discussed before.

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Table 4.2. *(continued)*

Code	Indicators	Definition	Examples from this study
EX3	Suggestions for consideration	Proposals and calls for time allocation, task allocation, and task procedures etc†.	Let's decide how to write roughly and then divide the work. Then let's watch this one and discuss later. Let's think about the title and decide it together. Let's first think about which excerpts we are going to analyze. You guys can think about a few more of (the title). Let me say it first. The we decide XXX?
		Suggestions for ideas of writing and specific writing†.	(We can analyze) the changes in emotions of the little girl after house-moving. I think we can first select a few excerpts showing her emotional changes, and we don't have to talk about them all. Just a few sentences in the last part.
EX4	Offers opinions.	Offers unsupported opinions.	We will not find a theme if the keywords are too scattered. I think the topic of depression is interesting. The theme of winter might be related to setbacks. I think these four (themes) all seem suitable, at the first glance. (The part of) the choice of film theme and reasons are easy to write. I think these two films involve a lot of content knowledge, although I don't know what the knowledge is.
		Undiscussed manuscript†.	(Part of) the uploaded manuscript that is not discussed.

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Table 4.2. *(continued)*

Code	Indicators	Definition	Examples from this study
IN1	Integration among groups members	Reference to previous message followed by substantiated agreement or disagreement (I agree/disagree because…) Building on, adding to others' ideas	This is ok. Because if Joy didn't abandon Sadness, there wouldn't be the plot that the girl reflects and wakes up.
IN2	Integration within a single message (response to prompt)	Justified, developed, defensible, yet tentative hypotheses.	I think in order to reflect Lily's interpersonal relationship, we should start from Friendship Island. Her former friends formed one of her core personalities, but when this relationship was temporarily broken, her island also collapsed. I mean, the themes are okay, but we should talk about the reasons why we choose these themes. That is to say, we can be more specific instead of choosing for choice.
IN3	Connecting ideas. Synthesis	Integrating information from one or more sources – textbook, articles, personal experience, other posts or peer contributions.	I read some academic articles about depression and integrated into our report.
IN4	Creating solutions	Explicit characterization of message as a solution by participants.	Revised uploaded manuscripts etc. after group discussions.
RE1	Vicarious application to real world testing solutions.	Providing examples of how problems were solved.	How we solved this problem was‡…
RE2	Defending solutions.	Defending why a problem was solved in a specific manner.	

Note: † Extension or revision of the original coding scheme; ‡ The example from the original coding scheme.

Analyses

To answer the first two research questions, descriptive statistics were used for the components and sub-components of social presence, and the levels and the sub-levels of cognitive presence in students' online discussions. For the third and fourth research questions, stepwise multiple regression analyses were first conducted with the artifact performance as the dependent variable, the three components of social presence and the four levels of cognitive presence as independent variables, respectively, and the total number of words as the covariate. Furthermore, the sub-components of the same category of social presence and sub-levels of the same category of cognitive presence were adopted as independent variables with the artifact performance as the dependent variable, and the total number of words as the covariate to perform separate stepwise multiple regression analyses for social and cognitive presences.

4.4 Results

The findings of the distribution of student social and cognitive presences in the online discourse and their relationship with the performance of student film report are presented in this section.

4.4.1 Levels of social presence and cognitive presence

Regarding social presence (see Table 4.3), almost half of students' discussion posts lied at the component of affectiveness (49%), followed by open communication (32%) and group cohesion (19%). However, the number of posts in each group of these three components varied greatly. When looking at each component in detail, regarding affectiveness, AF4 accounted for 66% of students' affective posts, meaning that students used a large number of unconventional expressions in their text conversations, compared to the use of conventional expressions (AF1, 4.3%). As for open communication, more than half of the posts were about students' asking questions to each other (OC3, 50.3%) and almost 40% of the discussion was about students' responses

to each other by posts (OC1, 38.3%). With regard to group cohesion, most of the students' posts used inclusive pronouns (CH2, 46.8%). Moreover, many students referred to group members' names in the discussion (CH1, 35.3%).

As for cognitive presence (see Table 4.4), 95% of students' posts contributed to the level of exploration, followed by integration (2.5%) and triggering event (2.5%). Similarly, the number of posts posted by each group in these three levels varied greatly, especially for exploration. No discussions could be related to the level of resolution. More specifically, students' posts involved all four sub-levels of exploration. Most of the discussions were about suggestions to complete the project (EX3, 32.53%) and the exchange of information about the project (EX2, 30.28%). Within the limited number of posts of triggering event, almost all were about starting a new direction of discussion (TE2, 98.1%). In terms of the level of integration, most posts were about the provision of project solutions (IN4, 52.73%) and developed hypotheses (IN2, 37.27%).

Table 4.3. *Descriptive statistics of components and sub- components of social presence (N = 24)*

	M	*SD*	*N*	%
1. Affectiveness	**122.29**	**110.35**	**2933**	**49**
AF1	5.21	7.91	125	4.3
AF2	18.33	21.26	440	15
AF3	17.38	18.57	417	14.2
AF4	80.67	69.68	1936	66
AF5	0.63	1.06	15	0.5
2. Open Communication	**80.33**	**55.97**	**1928**	**32**
OC1	30.79	23.51	739	38.3
OC2	0.46	0.59	11	0.6
OC3	40.42	29.75	970	50.3
OC4	5.42	6.09	130	6.7
OC5	1.33	2.50	32	1.7
OC6	1.92	1.95	46	2.4
3. Group Cohesion	**46.88**	**37.92**	**1125**	**19**
CH1	16.54	17.10	397	35.3
CH2	21.96	19.79	527	46.8
CH3	5.21	6.04	125	11.1
CH4	2.88	2.64	69	6.1
CH5	0.29	0.55	7	0.7

Table 4.4. *Descriptive statistics of levels and sub-levels of cognitive presence (N = 24)*

	M	*SD*	*N*	%
1. Triggering event	**4.42**	**5.45**	**106**	**2.5**
TE1	0.08	0.28	2	1.9
TE2	4.33	5.31	104	98.1
2. Exploration	**165.13**	**141.76**	**3963**	**95**
EX1	37.25	36.81	894	22.56
EX2	50	38.05	1200	30.28
EX3	53.71	51.87	1289	32.53
EX4	24.17	23.10	580	14.63
3. Integration	**4.58**	**4.92**	**110**	**2.5**
IN1	0.42	0.97	10	9.09
IN2	1.71	2.61	41	37.27
IN3	0.04	0.20	1	0.91
IN4	2.42	2.26	58	52.73
4. Resolution	**0**	**0**	**0**	**0**
RE1	0	0	0	0
RE2	0	0	0	0

4.4.2 Relationship between social presence, cognitive presence, and academic performance

The results of stepwise regression analyses of both components and sub-components of social presence and levels and sub-levels of cognitive presence as predictors are presented. The results indicated that the component of affectiveness was the only significant predictor of all components of social presence for the score of the film report (see Table 4.5), which explains 33.5% of the variance ($R = .579, F\,(1, 22) = 11.095, p < .01$). The results also revealed that the level of exploration was the only significant predictor of all levels of cognitive presence for the film report performance (see Table 4.6), which explains 33.3% of the variance ($R = .577, F\,(1, 22) = 10.972, p < .01$)

The results for each sub-component of social presence and sub-level of cognitive presence are presented (see Table 4.7). We only present the results if at least one of the sub-components or sub-levels showed a significant result. More specifically, a) in model affectiveness, AF2 was the only significant predictor of all sub-components of affectiveness for the artifact performance, which explains 32.2% of the variance ($R = .567, F\,(1, 22) = 10.446, p < .01$); b) in model group

cohesion, CH1 was the only significant predictor of all sub-components of group cohesion for the quality of the film report, which explains 32.7% of the variance ($R = .571, F\,(1, 22) = 10.667, p < .01$); and c) in model exploration, EX4 acted as the only significant predictor of all sub-levels of exploration for the score of the film report, which explains 40.7% of the variance ($R = .638, F\,(1, 22) = 15.109, p < .01$). In addition, in the rest models, namely model open communication, model triggering event, and model integration, only the covariate, namely the total number of words showed a significant result, which explains 28.3% of the variance ($R = .532, F\,(1, 22) = 8.703, p < .01$).

Table 4.5. *Stepwise regression analysis for social presence predicting artifact performance (Model 1, N = 24)*

Variable	*B*	*SE*	β	*R*	R^2	ΔR^2	*F*
Constant	41.522	2.568					
Affectiveness	.052	.016	.579	.579**	.335	.305	11.095**

Note: ** $p < .01$

Table 4.6. *Stepwise regression analysis for cognitive presence predicting artifact performance (Model 2, N = 24)*

Variable	*B*	*SE*	β	*R*	R^2	ΔR^2	*F*
Constant	41.229	2.646					
Exploration	.041	.012	.577	.577**	.333	.302	10.972**

Note: ** $p < .01$

Table 4.7. *Stepwise regression analysis for sub-components of social presence and sub-levels of cognitive presence predicting artifact performance (N = 24)*

Model	Variable	*B*	*SE*	β	*R*	R^2	ΔR^2	*F*
Affectiveness	Constant	43.052	2.287					
	AF2	.266	.082	.567	.567**	.322	.291	10.446**
Group cohesion	Constant	42.420	2.404					
	CH1	.334	.102	.571	.571**	.327	.296	10.667**
Exploration	Constant	41.273	2.348					
	EX4	.276**	.071	.638	.638**	.407	.380	15.109**

Note: The indicators of Open communication, Triggering event, and Integration were not significant; ** $p < .01$

4.5 Discussion

This study aims to contribute to our understanding of students' social and cognitive presences in online project-based learning and how they are related to student academic performance. To this end, based on the Community of Inquiry framework, 24 groups of student online discussions were coded socially and cognitively and their relationship with student artifact (i.e. a film analysis report) was examined.

4.5.1 Social presence

Regarding the first research question, among the three components of social presence, affectiveness accounted for up to half of student social presence in online discussions, followed by open communication and group cohesion. This result is in line with the findings of previous studies (e.g. Kilis & Yildirim, 2019; Li & Yu, 2020; Swan, 2003). It is not surprising that learners actively socialized with others during group discussions. When the course was implemented, students were first-year college students who just started their second semester. However, they were forced to separate from their peers and participated in online learning due to the breakout of COVID-19. Thus, the willingness of these students to establish, maintain, and make up personal relationships might have been particularly strong. Furthermore, the result also confirmed Brown's (2001) depiction of the process of establishing an online learning community. A quality community is built by three hierarchical steps, namely from the most common stage of students' emotional communication and friend-make with others (i.e. affectiveness) to the second phase of participation in long and thoughtful discussions (i.e. open communication), and to the most core stage of camaraderie (i.e. group cohesiveness).

It is worth noting that students' unconventional emotional expressions, such as emoticons and stickers, appeared frequently, which is typical for students using WeChat to communicate. There are some benefits of communicating in this way in online group discussions. First, since online group learning is mostly mediated by technology that supports verbal communication, it is hard

to get non-verbal communication cues (Robinson, 2013). This might lead to the misunderstanding of each other's intention as it is not easy for students to "discern the flavour of a reply" (Murphy & Coleman, 2004, p. 6). Using emoticons (e.g. an angry face) in an environment where students cannot see each other can accurately express their tones, emotions, or attitude, and so on. Besides, conflicts have been identified as a typical element of collaborative learning (Robinson, 2013). When students have different opinions in communication, the emoticons and stickers could act as mitigators for the potential emotional conflicts. In addition, when the team leader assigns tasks to team members or urges them to complete assignments, the atmosphere could become less formal and tough with the adding of some vivid expressions.

4.5.2 Cognitive presence

Regarding the second research question, the majority of student cognitive presence was at the exploration level. This finding is consistent with the claim of Garrison and Arbaugh (2007) that it is not easy for learners to move beyond the exploration phase in the discourse and in line with the findings from the previous research (e.g. Jo et al., 2017; Kilis & Yildirim, 2019; Zydney et al., 2012). The reason of this result might be that to complete the final artifact in a short period, group members needed to reach consensus on many different tasks, which required a lot of information exchange and discussions. More specifically, students needed to watch all video lectures and the four films in order to get the basic knowledge of the course and the films. However, it was found that not everyone finished the watching. Therefore, it was necessary for team members to exchange relevant information and compensate the lack of information. Afterwards, students needed to report, discuss, and reach agreement on a series of subtasks. These mainly included the discussion and selection of the film excerpts for analysis, the allocation of tasks and schedule, the ideas and suggestions on the writing, and the progress report of each member and so on.

The results also showed that students barely reached the integration level, which is different from the findings from previous studies (e.g. Akyol & Garrison, 2011; Galikyan & Admiraal, 2019; Oh et al., 2018; Richardson & Ice, 2010).

The reason might be related to the design of the problem that learners solved, including the structure and the nature of the problem. Darabi et al. (2011) also concluded that different types of discussion strategies could cause different cognitive levels. Regarding the structure, a well-structured problem normally means that its objectives are clear and the question can be elaborated directly. For example, in the study of Oh et al. (2018) students just needed to choose their perspectives for the debating question and articulated on them. In our study, however, due to the characteristic of the ill-structure and openness of the film report, students had to spend a large amount of time on the exploration phase first and then had the possibility to reach the higher cognitive level. This might further cause the problem that learners had little time to reflect on the problem. After all, it is believed that "students learn by doing, but only when they have time to reflect on what they are doing" (Ambrose, 2013, p. 20). As for the nature of the problem, some problems, such as ethical dilemmas that elicit debates or negotiation (Oh et al., 2018), are equivocal in nature which might contribute to higher-order cognitive processing and understanding (C.-J. Liu & Yang, 2012; E. Zhu, 2006). The film analysis report in the present study, however, is not necessarily an assignment with high demands on cognition. Some topics of this course, such as happiness and depression, are closely associated with students' daily life, and therefore, students could use the so-called "life experience" to express their own views on certain issues, even without a deep understanding of curriculum knowledge. In this case, it is understandable that students' discussions did not reach high cognitive levels.

In addition, no resolution level was reported in student discourse, which shows similarities with the results of previous studies (e.g. Gašević et al., 2015; Kaul et al., 2018; Richardson & Ice, 2010; Vaughan & Garrison, 2005). This result might confirm the claims of Garrison and Cleveland-Innes (2005) and Garrison and Arbaugh (2007) that the more advanced cognitive level cannot be naturally reached in an online inquiry community. This is reflected by the course setting of this study. Based on the idea of teachers' role in PjBL, the course teacher did not join in each student group and provide them with instructions but acted as a learning facilitator in the course group. However, without the participation

and detailed guidance of teachers, the cognition processing of students tends to be a shallow exchange of information (Zhu, 2006), particularly for learners who are not familiar with online discussions. Furthermore, Richardson and Ice (2010) raised a question worth thinking about whether we should pursue the resolution level in online discourse.

4.5.3 Social presence, cognitive presence, and academic performance

Regarding the third research question, the results showed that students' expression of affectiveness in online discussions could benefit their academic performance, consistent with the results of previous studies that have examined the relationship between affective factors and cognitive learning outcomes (Denton & McKinney, 2004; Kormos & Préfontaine, 2017; Nasser, 2004). This finding supports the claim of Piaget (1989) that affective aspects can have strong effects on cognitive processes (as cited in Reis et al., 2018) and in the environment of computer-supported collaborative learning, in particular (Jones & Issroff, 2005). The findings further indicate that the use of humor during online discussions contributed to academic performance, which shows similarities with the results of some recent studies that have reported the positive influence of students' perceptions of humor use, either in the class (e.g. Çelik & Gündoğdu, 2016) or during collaborative projects (e.g. Selcuk, 2017), on students' academic achievement, such as the level of content knowledge and writing skills. The type of humor is usually categorized into two dimensions: positive or affiliative, and negative or aggressive (Banas et al., 2011; Martin et al., 2003). Positive humor aims to please others, build and develop bonds, and decrease pressure (Banas et al., 2011). In this study, most of the humor that students used during their group discussions was positive humor, such as "I wish you good luck, your majesty", "please allow me to nag a few more sentences", and "we haven't finished watching the lectures, baby". The role of the use of affiliative humor has been concluded by the review study of Banas et al. (2011), showing that it is related to an interesting and comfortable learning environment in which students could perceive greater motivation to learn, which might further contribute to their academic performance.

The findings also revealed that vocatives or addressing others by name was frequently used by students and it was positively related to the performance of their group work. Although previous studies have reported that the use of vocatives was often found in teachers' facilitation in online asynchronous discussions and MOOC education (e.g. Evans et al., 2020; Goshtasbpour et al., 2020), research has also reported that online students used a lot of vocatives via online communication tools like Twitter (e.g. Baisley-Nodine et al., 2018). Cleveland-Innes et al. (2019) claimed that the significant role of vocatives is that it could initiate a cohesive environment of communication where students' capacity for collaboration might increase. The results of Williams et al. (2006) showed that the cohesiveness of a group could positively influence students' cognitive learning outcomes.

As for the fourth research question, the results showed that the quality of group artifact was closely related to student presence of exploration, which is different from the findings of Galikyan and Admiraal (2019) which showed that the cognitive presence of integration and resolution —and not exploration— were significant predictors of student academic performance. In their study, student teachers had well-structured discussions on the reflection of their teaching practice based on the guidance of Bloom's Taxonomy. Therefore, a high requirement of cognition was expected from students. In the present study, however, as can be seen from the assessment criteria of the film analysis report, there were no high requirements set for students at the cognitive level. Instead, it primarily aimed to encourage students' acquisition and application of the content knowledge. Nevertheless, this finding still showed that the exploratory phase is a very important stage in online PjBL. Our results further found that offering opinions predicted the quality of the report, although the frequency of this indicator was the least among all exploration indicators. This might indicate that whether it is the exchange of information between students, making suggestions, or agreeing/disagreeing with each other, the ultimate goal is to motivate students to put forward opinions.

4.5.4 Implications for practice

A first implication for practice of the current study can be related to the design and organization of the project. Some groups spent too much time and effort on the exploration phase, particularly on the exchange of the basic information of the course lectures and films that they were supposed to acquire before the discussions started. Students in future projects should be required to finish learning the basic course materials before they set up and participate in group discussions. Second, although previous research has indicated the important role of teachers in promoting students' higher-level cognitive presence (Garrison, Anderson, et al., 2010; Garrison, Cleveland-Innes, et al., 2010; Oh et al., 2018), it is a pity that little of it appeared in the conversations in this study due to the lack of teachers' facilitation in this project. In future projects, teachers might consider assisting students with the direction of the discussion. For example, they could help students to narrow the scope of the topics and knowledge to be used and guide them to find the associations between film excerpts and content knowledge. Furthermore, teachers could design and propose some questions that students could debate. For example, a good debating question regarding mental health is "is it necessary to screen for depression among the first-year college students?".

4.5.5 Limitations and future directions

A first limitation of the current study relates to the results of the level of social and cognitive presences. During the discussion, students frequently used humor, disclosed themselves, used many emojis and stickers, and mentioned each other's names. These observed levels of social presence might be triggered by the intimacy between group members and the small size of the group. Moreover, students' cognitive presence was mainly concentrated in the exploration phase, which might be related to the goal and type of the task, namely knowledge construction through ill-structured projects, and the lack of teachers' instructions and facilitation. In short, these findings might be specific for the way that social and cognitive presences were triggered in the current study. Other loose student groups and larger student groups might trigger

different forms of social presence and other task types and ways of guidance by teachers might also trigger different cognitive presence. Future studies could include a variety of course setups, both in the domain of social and cognitive presences, to provide a more comprehensive overview of students' social and cognitive presences in online PjBL. Second, the content of the audio calls of some groups was not recorded. This might lead to an incomplete understanding of students' social and cognitive presences in online discussions. The loss of the data of certain online group behaviors was also reported in previous studies (e.g. Kaul et al., 2018; Tirado-Morueta et al., 2020). Future studies using similar communication tools like WeChat (e.g. WhatsApp) may record and analyze all categories of student data. Third, we focused on students' online discussions in all 24 groups as a whole, which ignores the differences within groups. Future studies could examine and compare the pattern of students' presence in each group via the social network analysis (e.g. Jo et al., 2017; Oh et al., 2018). In addition, since students need to conduct a series of activities during PjBL, future research could closely examine the level of student social and cognitive presences in each activity so as to better understand students' learning process in online PjBL. Furthermore, in order to deeply understand the relationship between students' presence and artifact performance, an explanatory sequential design (Creswell, 2012; Leavy, 2017) is suggested to be adopted in future studies. This means after the collection and analysis of quantitative data like in this study, qualitative methods such as interviews are adopted to further explain the quantitative results.

4.6 Concluding remarks

This study has contributed to our understanding of college students' performance during online project-based learning, based on the Community of Inquiry framework. It can be concluded from the results that the expressions of affectiveness and exploration are the most frequently used social and cognitive presences during students' online group discussions, respectively. In addition,

students' group academic performance was positively related to the social presence of affective expressions, humor use, and vocatives and the cognitive presence of exploration and offering opinions. These findings can serve as guidelines on how to better design and organize online group projects and promotes students' academic performance in online project-based learning.

The most significant theoretical contribution of the current study is providing a comprehensive understanding of students' learning processes in online PjBL based on the CoI framework. As discussed earlier (see Section 4.2.4), previous literature have focused on students' social and cognitive presences during the discussion on given questions that are clear and well-structured with guidelines and examples (e.g. Evans et al., 2020; Galikyan & Admiraal, 2019; Jo et al., 2017; Joksimović et al., 2015; Kaul et al., 2018; Kilis & Yildirim, 2019; Kim, 2014; C.-J. Liu & Yang, 2012; Oh et al., 2018; Richardson & Ice, 2010), which mainly investigates students' problem-solving via the acquisition and application of existing knowledge. This study, however, not only focuses on problem-solving but also, which is important for college students, on the construction of new information through the creation of project artifacts.

Accordingly, this study also improves the instrument for the analysis of students' social and cognitive presences (i.e. the coding scheme), making it suitable for students using instant messaging apps (e.g. WeChat) for PjBL. We found that the type of students' social presence when using WeChat to communicate is more than that when using online forums in Shea et al. (2010). Regarding the expression of emotions, students used many emojis and stickers to express their emotions. As for the open communication, students had many meaningless responses to others' messages, which is common in conversations on instant messaging apps. The improved coding scheme can capture these two sorts of data (see Table 4.1). Moreover, during PjBL students need to do a series of activities, such as defining problems, deciding methods, collecting and analyzing data, and presenting results. These activities cannot be directly implemented and often contain various tasks, such as task selection and allocation, time allocation and management, and progress check. The updated coding scheme adopted in this study can capture these indispensable aspects

of students' cognitive presence (see Table 4.2). In short, this improved analysis instrument will help analyze students' learning behavior in online PjBL in future studies.