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Exploring social and cognitive presences in communities of inquiry to perform higher cognitive tasks

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ABSTRACT

The purpose of the current study was to explore social and cognitive relationships among students when they are solving complex cognitive tasks in online discussion forums (self-regulated). An online course targeting interventions for risk behaviors was developed in the Virtual Campus of Andalusia, Spain. A total of 9878 units of meaning posted in 96 online discussion forums during three academic years (2010–11, 2011–12 and 2012–13) were analyzed through the Community of Inquiry (CoI) framework. The degree to which online tasks at three different levels of cognitive demand (analyze, evaluate and create) triggered cognitive and social processes were examined. The results indicate that there was a specific increasing trend in the frequency of cognitive and social activity according to the requirement of the task. This study also found that the nature of the learning task modulated the different components of social and cognitive presence in these contexts.

1. Introduction

Universities and other institutions of higher education are increasingly incorporating technologies in instructional settings to enhance teaching and learning experiences. Multiple studies support the benefits of using online technologies to enhance learning in higher education (Hamid, Waycott, Kurnia, and Chang, 2015; Lee, 2014). As a result, the number of higher education students taking online courses continues to grow.

The impressively fast growth of online learning is challenging higher education institutions to ensure that their online programs and courses have the same high quality as their traditional classes. Most of these online courses are being developed within a Learning Management System (LMS) software application. Within this context and platform, discussion forums allow high levels of student–student and student–instructor interaction which support teaching and learning models suitable for higher education. Moreover, research has shown that asynchronous online discussion is an ideal tool for supporting knowledge construction because students can cooperate and communicate with their peers, share knowledge, and solve problems, all of which catalyze high-level thinking (e.g., De Wever, Van Keer, Schellens, and Valcke, 2010).

Although there are numerous examples that have proven the effectiveness of discussion forums for collaborative knowledge construction, remains concerned about the knowledge of the factors and processes that explain the success (or failure) of collaborative online learning. For this scope, many models and frameworks have been developed to understand the knowledge construction process generated by online discussion (see, De Wever, Schellens, Valcke, and Van Keer, 2006).

For decades it has been shown that the effort and strategies for students to learn, is determined by the task or learning outcome expected (Marton and Säljö, 1976). However, recent studies (e.g., Akyol & Garrison, 2011a,b; Wicks, Craft, Mason, Gritter, and Bolding, 2015; Szeto, 2015) emphasize that findings related to collaborative learning processes that occur in a community of inquiry with different subjects and types of higher order learning outcomes are insufficient.

Also, are lacking robust studies both reliability and validity, and it is common to find research that insists on the need for research studies to understand more deeply the processes and outcomes of learning in communities of inquiry (e.g., Shea, Vickers & Hayes, 2010).

With this background, and given the current situation, the objective of this research is to understand the social and cognitive processes that students perform in communities of inquiry, considering the type of learning tasks of higher order.

To approach this goal, the main measures taken were the following. First, the Community of Inquiry (CoI) model (Garrison, Anderson, and Archer, 2000) is used, because appears to be the most suitable for analyzing data in a text-based online forum in higher education. In addition, numerous studies have demonstrated its validity to analyze the processes of online learning associated with higher order learning

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outcomes (e.g., Swan, Garrison, and Richardson, 2009; Garrison, 2011; Akyol & Garrison, 2011a,b; Garrison and Akyol, 2015; Szeto, 2015). Secondly this study took as reference the taxonomy of Bloom for controlling the learning task, so that each group of students had to perform three suitable to the last three levels of the taxonomy tasks in addition to an introductory task. Third, to strengthen the reliability of the results, among other measures (through content analysis) over three academic years, 24 student groups (created ad hoc), and 96 discussion forums (self-directed) are observed.

After introducing the problem and the objective of this research then an analysis of previous studies using the CoI model (Garrison, Anderson, and Archer, 2001) to understand the processes of online collaborative learning is presented. Moreover, the current situation and research questions are presented. In the next two sections, the method used to answer research questions is explained in detail, and the results are presented. Finally, the results are discussed, their educational implications, and conclusions and limitations of this research are presented.

2. Background

While there are various models for the analysis of the online learning (see De Wever et al., 2006), the authors based the current study on the model proposed by Garrison et al. (2001), a framework that has provided significant insights and methodological solutions for studying online learning (Garrison and Archer, 2003; Garrison, Cleveland-Innes, Koole, and Kappelman, 2006). In higher education, the Community of Inquiry (CoI) framework is generally viewed as a dynamic model of the necessary core elements for both the development of community and the pursuit of inquiry, which are required for higher-order learning (Swan et al., 2009; Garrison, 2007, 2011). The CoI framework, stemming from Dewey's emphasis on collaborative constructivism and practical inquiry holds promise as a theoretical and practical model for online learning. At the heart of the CoI framework is the idea that community, critical reflection, and knowledge construction are integral to learning, especially learning online (Garrison et al., 2000, p. 91).

The structure of the CoI framework has been confirmed through factor analysis by Garrison, Cleveland-Innes, and Fung (2004) and Arbaugh and Hwang (2006).

During the last fifteen years, many researchers have studied and analyzed educational experiences according to the CoI framework (e.g., Kozan and Richardson, 2014; Tirado, Hernando, and Aguaded, 2012; Akyol & Garrison, 2011a,b; Wicks et al., 2015; Szeto, 2015). The CoI model focuses on learning processes from a collaborative, constructivist point of view. The model also assumes that learning in online environments occurs through the interaction of three core elements: social presence, cognitive presence, and teaching presence. These elements work together to support deep and meaningful online inquiry and learning.

The first element, social presence, is defined as the ability of students to project themselves socially and affectively into a community of inquiry (Rourke, Anderson, Archer, and Garrison, 2001). Social presence is divided into three categories affective, interactive, and cohesive and reflects a supportive context for emotional expression, open communication, and group cohesion for the resolution of the respective task. Social presence, an important factor critical to face-to-face teaching, is a challenge for instructors to facilitate in online learning environments.

However, it is essential in a collaborative learning experience and is an essential element in establishing cognitive presence (Garrison, 2011). Cognitive presence refers to the extent to which online students can construct and validate meaning based on communication and thinking (Garrison et al., 2000, 2001).

The CoI model categorizes cognitive presence into four phases with specific descriptors for each phase: 1) a triggering event (an issue is identified for inquiry); 2) exploration (exploring the issue through discussion and critical reflection); 3) integration (constructing meaning from the ideas developed through exploration); and, 4) resolution (applying new knowledge into a real-world context).

The third element of the CoI model is teaching presence. It consists of two general functions: 1) the design of the educational experience; and, 2) facilitation among the instructor and the students. It is the responsibility of the instructor to design and integrate both cognitive and social presence for educational purposes through scaffolding, modeling, and/or coaching.

Interest in understanding the processes of learning through the CoI framework, and its relationship with learning outcomes of higher order is based on the study by Marton and Säljö (1976), in studying different learning strategies used by students and their different results. Marton (1988) indicated that lesson learned (the result), and how it is learned (the process) are two inseparable aspects of learning. Therefore, the process and the result are intimately associated. In this sense, Akyol and Garrison (2008) conducted a study through content analysis, in order to show how the CoI framework progresses during the learning process, finding that cognitive and teaching presence are determined primarily by the task and not by time.

The results from research on the CoI framework, have shown the importance of considering the disciplines, and contents/coursework as study variables (Swan et al., 2009). However, there are few studies which deepen the processes and outcomes (related) learning. For example, Akyol & Garrison (2011a,b), applying mixed methodology, with the purpose of understanding cognitive presence in an online and blended community of inquiry, suggest that cognitive presence in a community of inquiry is associated with perceived and actual learning outcomes. In this study the authors used as learning tasks: critical analysis of articles, online discussion activity, and a project to redesign a course. However, the study does not use the learning task (outcome) in data analysis.

Also, in the study of Wicks et al. (2015) using the Comunity of Inquiry Survey (Arbaugh et al., 2008) the influence of the field of study (engineering, nursing, psychology and economic) on social presence, cognitive and learning is stressed. However, the study only considers the global measures of the three types of presence, and neither delves into the type of task (outcome) academic.

Moreover, studies which deepen the functioning of the three presences in the CoI model, neither often consider the type of task (outcome) learning. For example, Siemens et al. (2011) using the CoI Instrument showed that community of inquiry and the construction of knowledge arise from the three presences. Also, Shea and Bidjerano (2009), using a structural equation model showed the direct influence of the teaching presence and indirect social presence on cognitive presence. They claim that the social/teaching presence represent necessary steps to stimulate cognitive presence in online student process. On the other hand, Akyol & Garrison (2011a,b), using an online and blended format with learning tasks of a higher order (article criticizing assignment and course redesign prototype Project), in which the authors concluded that it is important that all presences are present and in balance (in case of using a blended format).

However, these advances show the overall performance of the model. Although the task (outcome) learning is generally considered in most of these studies are still few studies that integrate the type of learning task analysis among the variables (e.g., Richardson and Ice, 2010 [case study]; Koh, Herring, and Hew, 2010 [project-based tasks]).

Therefore, given the relevance of the learning task in defining the learning process, it is necessary to conduct studies that consider it as a central element in the analysis of model performance.

As mentioned in the introduction, this study seeks to understand the processes of online collaborative learning, considering the type of higher order learning task. For this purpose, in this study the type of learning task is used as a reference throughout the research process.

For this purpose, the Bloom's taxonomy is used, because is a well-known and widely used schema, was also used to better understand the systematic classifications and processes of thinking and learning in an online learning environment (e.g., Liu and Yang, 2014) When an instructor desires to move a group of students through a learning process utilizing an organized framework, Bloom's Taxonomy can prove helpful (Forehand, 2005). In the current study, the authors considered three higher order thinking levels from the revision of Bloom's Taxonomy (Anderson and Krathwohl, 2001, pp. 67–68): (a) *analyzing:* breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing; (b) *evaluating:* making judgments based on criteria and standards through checking and critiquing; (c) *creating:* putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Based on the above research goals, this exploratory case study investigated the following questions through the use of CoI model and considering the last three levels of Bloom's taxonomy:

RQ1 What are students' social and cognitive categories in CoI when they have to perform learning tasks of higher order cognitive complexity?

RQ2 How do social and cognitive actions correlate depending on the requirement of the learning task?

3. Methods

3.1. Participants

During three academic years (2010–11, 2011–12 and 2012–13), a total of 206 university students from different degree areas and from 9 universities across Andalusia, Spain participated in the current study. Each of these students participated in a common online course. The first year, 71 students participated in the course; the second year, 77 participated; and, the last year, 64 participated. Students ranged in age from 19 to >51 years-old. Approximately 80% of the students were female.

3.2. Procedure and data analysis

Data were collected using the messages created by each group in the forums for the online course (taking into account the instruments developed by Anderson and Krathwohl (2001); Garrison et al. (2000, 2001) and Rourke et al. (2001) for measuring social presence (Appendix A) and cognitive presence (Appendix B). For the content analysis, the thematic unit (Aviv, Zippy, Gilad, and Geva, 2003) was identified as the unit of analysis. The units of analysis were the "units of meaning," not the specific messages. A unit of meaning can be defined simply as a thought or idea (Rourke et al., 2001). Units of meaning include expressions, sentences or paragraphs in which important thoughts and ideas (meanings) are conveyed. Depending on the semantic sense used, several units of meaning could be conveyed in each message. A total of 9878 units of meaning were coded into the qualitative analysis program AtlasTi v.6.

Content analysis was used to analyze the participation of students. Researchers often use the transcripts of online discussions to investigate the process of social construction of knowledge (Gunawardena, Lowe, and Anderson, 1997). According to De Wever et al., 2006, "In general, the aim of content analysis is to reveal information that is not situated at the surface of the transcripts. In-depth understanding of the online discussions is needed to be able to provide convincing evidence about the learning and the construction of knowledge that is taking place" (p. 7).

In accordance with the principles of systematicness, objectiveness, and reliability of content analysis indicated by Rourke and Anderson (2002), three coders classified the messages using the CoI model. The researchers followed the categorization of the CoI model and coded the messages into cognitive or social presence, classifying the messages into the categories within each presence with indicator notes for each message. Messages were coded in the chronological order in which the messages were posted in the discussion forums. Examples for each category and indicator are found in Appendix A and B.

The statistical package macro (KALPHA) by Hayes and Krippendorff (2007) was used for the calculation of the interrater and intra-rater reliability coefficient Krippendorff's alpha. The global output from the macro Krippendorff's ordinal α is 0.7666, a modest degree of interrater reliability. The first year Krippendorff's α is 0.7149. The second year Krippendorff's α is 0.6915 and the third year is 0.8615. In addition, the intra-rater reliability (the degree of agreement among repeated administrations of a diagnostic test performed by a single rater) is 0.9214. These values for Krippendorff's alpha are situated within the classification 'fair to good agreement beyond chance'.

The data was then imported into SPSS v.21 in order to conduct quantitative analysis. In the numerical matrix of imported data, each indicator becomes a quantitative variable that reflects its frequency of occurrence for each participant ($N = 206$). In answering the first question, an analysis of the mean and standard deviation of the seven categories (three social presence and four cognitive presence) in each type of learning task was performed. ANOVA was performed in order to see if there are significant differences among the mean values. In order to identify stable patterns over time, this analysis is performed in three consecutive academic years.

For responding to the second question, it is performed on each type of task, a correlation analysis (Pearson) between the values of the average of the 7 categories (in the three academic years).

3.3. Experimental setting

The present study took place at the Virtual Campus of Andalusia, Spain where students from 9 public universities from the Andalusian region of Spain participated in a common online course through Moodle LMS. The online course is called, "Intervention on risk behaviors". This course is offered since 2008 to the present. It can enroll up to 10 students from each of the public universities of Andalusia, and from different academic areas (social, engineering, experimental, and health). This case was chosen for the following reasons: (a) for its high application (100% of places are usually covered); (b) because of the quality academic outcomes, and low dropout rate (10.6% [2010 − 11], 12.2% [2011 − 12] y 14% [2012 − 13]); and (c) because of the different backgrounds and academic profiles of students. The study was based on group discussions among the participating students. A total of 96 discussion forums were conducted: 8 groups per three academic years for each of four group activities (including the first socialization activity which was not included in the analysis). The involvement of all participants has been high and quality. Participants have developed interesting proposals and resources as a result of social and cognitive interaction produced through this learning experience. The experience has been valued as excellent and recommended by the students.

Moodle discussion forums were employed to facilitate content delivery and to promote higher order thinking skills among the students. The required tasks were based on the skills that are present in the top three categories of the revision of Bloom's taxonomy. The course design was inspired by the model of Salmon (2004, 2013), because provides a staged, practical approach to teaching and learning online. In accordance with this model, was following steps:

In Step 1, 8 working groups were established, each one into a discussion forum where students were given directions for how to proceed by the tutor. In step 2, the first actions were performed, in order for students to socialize, exchange messages, interact and learn. In the step 3, three types of tasks were presented (Table 1) with different levels of cognitive demand that required participants in each group to share information, begin to engage in group work, and to share the same learning goal. In step 4, the learners focused on knowledge development and discussion activities.

Table 1
Online learning task.[a]

Skill	Task	Resources support
Analyzing Case Study (ACS)	Analyzing, in a collaborative way, the real-world case of a student from a secondary school.	Case description, scheme and help for the case analysis.
Evaluating Websites (EW)	Evaluating web resources which could be used to provide information about risky behaviors.	List of risky behaviors and example of the data sheet.
Creating WebQuest (CWQ)	Creating a WebQuest that could serve as a tool for information-training for drug prevention.	Web sources and examples.

[a] Based on Bloom's taxonomy.

Table 2
Units of analysis.[a]

Presence	Category	Task			
		ACS	EW	CWQ	TOTAL (%)
Social	Affective	327	401	512	1240 (13%)
	Interactive	462	871	1081	2414 (24%)
	Cohesive	626	693	1122	2441 (25%)
	Subtotal	1415	1965	2715	6095
Cognitive	Triggering	205	165	417	787 (8%)
	Exploration	698	285	976	1959 (20%)
	Integration	241	300	455	996 (10%)
	Resolution	15	8	18	41 (1%)
	Subtotal	1159	758	1866	3783
	TOTAL (%)	2574(26%)	2723(28%)	4581(46%)	9878(100%)

[a] Data were calculated based on the units of meaning.

The proposed tasks had different levels of cognitive demand. The Analyzing Case Study (ACS) task was to collaboratively analyze the real case of a problematic student and initially deliver a brief description of the case. In addition, a forum of expanded information for the Case Study was activated through which students could ask questions to the guidance personnel of the high school where the student was enrolled. In different blocks of contents, materials that could serve for the analysis of the case and the possible intervention proposals were presented.

The Evaluating Websites (EW) task consisted of evaluating web resources which could be used to provide information to families of adolescents and young people about risk behaviors. Each group searched websites and evaluated them. In the end, they produced a data sheet document in which multiple risky behaviors (drug use, risky sexual practices, not using passive protection elements in driving, aggressive behavior, eating disorders, etc.) were identified and evaluated.

The Creating WebQuest (CWQ) task consisted of two phases. In the first phase each group was required to look for information about how to build a WebQuest (e.g., what the components were; what rules must be followed in its construction; good examples of this tool, etc.). In the second phase, each group had to design a WebQuest which could serve as a tool for drug prevention information-training. Upon completion, all the WebQuests were uploaded to the network and shared with the other groups.

For conducting the assigned tasks, each of the eight working groups was provided a private forum for working together, an open forum for inter-meeting (as a space for discussion among the groups), and a file space for uploading or downloading documents. They were offered theoretical and practical resources that could also serve as a reference and support for the implementation of the tasks. Two different moderators were selected by the group to coordinate each task. Discussions were led by the moderator students, whose functions included stimulating and facilitating discussion, intertwining, and summarizing the discussion. One instructor monitored the interaction, becoming active only in case of necessity. As a result, teaching presence was not analyzed in this research.

4. Results

In this section, first, the authors show the number of units of analysis coded in each category of the interpretation system used (type of task/type of presence). Then, an analysis is presented in terms of the categories and the academic year. The analysis of three successive academic years assisted the authors with the exploration of finding stable patterns across academic years. Finally, a correlational analysis is performed.

4.1. Descriptive analysis

In order to address the first question of this study, the analysis focused on each presence (i.e., social, cognitive), in general. Based on the overall analysis regarding social and cognitive presence (Table 2), a remarkable difference between the two presences was observed. Social actions were more frequent than cognitive actions.

Regarding social presence, the most frequent actions were the interactive and cohesive-type, with affective being much less frequent. Regarding cognitive actions, the most common actions were the exploratory-type, followed by integration. Triggering actions were less common, coinciding with the start of the academic tasks, and resolution actions only occurred coinciding with the conclusion of the tasks.

Regarding the type of academic task, a progression was observed in the group participation frequency. In particular, it was noted that with the increase of the task's level of demand (in Bloom's taxonomy), there was an increase in the frequency of involvement by the group members. However, during the ACS task more cognitive actions occurred when compared to the EW task; in this task ACS a greater number of social actions occurred. Finally, with regard to the CWQ tasks, the results indicated a greater involvement by the group, both in social and cognitive presences.

Table 3 shows the descriptive results and patterns over the three academic years of the study and the scores (mean, standard deviation and ANOVA) of the type of group action in each of the three tasks analyzed during the three years of research. It is important to note that the pilot study took place during the first year and only one instructor participated in the experience. It should also be noted that in the pilot study participation was lower than in the following two years when there were two instructors who participated in the experience. In addition, greater participation occurred in year 2, when the number of students ($N = 77$) was higher than in the other 2 years.

Regarding social presence (Fig. 1), a stable trend was observed. The lowest social participation occurred during the ACS task and was higher in the EW task. The CWQ task showed greater social participation in all three academic years.

As for cognitive presence (Fig. 2), the CWQ task was the task that produced the greatest cognitive engagement during the three years.

Table 3
Descriptive results. Social presence.

	Year	ACS		EW		CWQ		*F*
		Mean	SD	Mean	SD	Mean	SD	
Affective	Year 1	0.50	0.73	0.74	1.06	1.18	1.41	8.25**
	Year 2	2.23	3.03	2.93	3.33	3.45	4.70	4.18*
	Year 3	2.16	2.72	2.29	3.15	2.97	3.45	2.466
Interactive	Year 1	0.93	1.22	3.01	3.55	2.36	2.78	26.34***
	Year 2	3.57	5.12	6.46	7.57	8.48	11.81	13.25***
	Year 3	2.33	2.63	3.21	3.30	5.10	5.83	7.894***
Cohesion	Year 1	1.57	2.61	2.49	3.44	5.03	6.76	13.85***
	Year 2	4.81	5.48	4.09	4.56	6.67	7.38	8.86***
	Year 3	2.83	3.20	3.60	3.93	4.60	6.15	3.522*

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

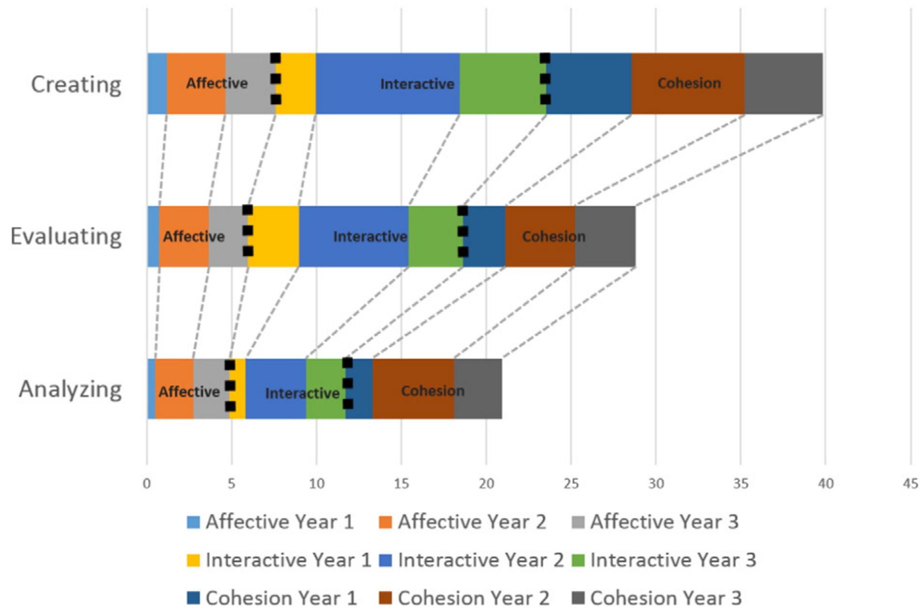

Fig. 1. Social presence.

The ACS task produced greater cognitive engagement than the EW task in the second and third academic years, although in the first year, the EW task produced greater cognitive engagement than the ACS task.

While examining social presence categories, the authors observed that both social participations, such as interactive and cohesion, were more frequent in the CWQ task. Conversely, during the ACS task, the least social participation occurred in all categories. The differences observed in social participation that were dependent on the type of task were particularly significant in the actions of interaction, as shown by the high F value in the three academic years. Also, it can be seen that in all three types of tasks, affective participations were less frequent than interaction and cohesion, which had a similar frequency, although the units of interaction were more frequent than those of cohesion in the EW tasks.

Lastly, with respect to the cognitive presence categories, the CWQ task was the task that produced the greatest cognitive participation in all categories (Table 4). Additionally, the level of group participation in the resolution category was almost non-existent, which did not mean it did not exist at the individual level. Furthermore, it was during the EW task that the least exploration occurred. In this task, activation, exploration and integration showed a similar frequency.

Also, in the ACS task, greater exploration actions occurred than in the EW task. Therefore, it appeared that the cognitive demand of EW and ACS tasks did not affect the cognitive participation of the group, except

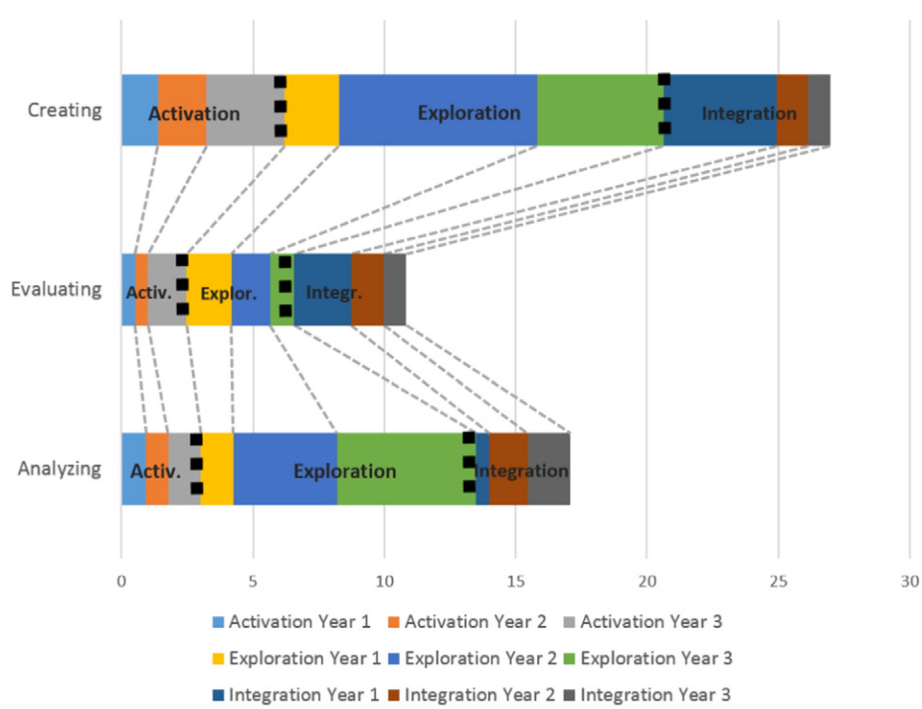

Fig. 2. Cognitive presence.

Table 4
Descriptive results. Cognitive presence.

	Year	ACS		EW		CWQ		*F*
		Mean	SD	Mean	SD	Mean	SD	
Activation	Year 1	0.93	1.93	0.51	0.86	1.38	2.17	5.44**
	Year 2	0.84	2.86	0.49	1.08	1.84	2.87	11.90***
	Year 3	1.24	2.05	1.48	2.34	2.98	3.85	7.850***
Exploration	Year 1	1.24	1.74	1.69	2.11	2.07	2.53	6.25**
	Year 2	3.94	6.96	1.48	3.22	7.54	10.85	12.95***
	Year 3	5.30	6.99	0.92	1.81	4.81	5.99	19.313***
Integration	Year 1	0.50	0.71	2.16	2.17	4.32	4.14	48.61***
	Year 2	1.46	2.02	1.25	1.29	1.19	2.29	0.39
	Year 3	1.63	4.23	0.86	0.80	0.84	1.71	1.47
Resolution	Year 1	0.04	0.26	0.11	0.31	0.19	0.46	3.37*
	Year 2	0.16	0.47	0.00	0.00	0.06	0.23	5.06**
	Year 3	0.02	0.13	0.00	0.00	0.00	0.00	1.000

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

for the actions of exploration, which were more common in the task of analyzing than in the EW task.

In summary, it may be concluded that the CWQ task led to greater cognitive participation of the group in all categories. Also, the ACS task required greater cognitive participation than the EW task. The category of exploration was the most frequent in the CQW and EW tasks.

4.2. Correlational analysis

Regarding the third question of this study, Table 5 shows Pearson correlations between the social and cognitive categories among the three tasks. As can be seen, there were high correlation levels among the categories of social presence and cognitive presence among the three tasks. Furthermore, the results indicated, in general, that in the ACS and CWQ tasks correlation levels showed greater strength. In the CWQ task, rates of correlation between categories of social and cognitive presence were the highest.

Regarding the relationship between social presence categories, the results indicated that the correlation coefficients were high in the three tasks, although higher correlations in EW and CWQ than in ACS tasks were observed. Among the three tasks, high levels of correlation between cohesion and interaction were observed.

Regarding the correlations between cognitive presence categories, differences in the three tasks were observed. On the one hand, activation category (clear identification of problem), in the three tasks correlated with exploration category, with stronger correlation in the CWQ task ($r = 0.538$; $p < 0.01$) than in the EW ($r = 0.424$; $p < 0.01$) and ACS task ($r = 0.375$; $p < 0.01$). On the other hand, the categories of exploration and integration had a strong correlation in ACS ($r = 0.266$; $p < 0.01$) and EW tasks ($r = 0.333$; $p < 0.01$). Finally, integration and resolution categories had a strong correlation index in the EW ($r = 0.311$; $p < 0.01$) and CWQ tasks ($r = 0.345$; $p < 0.01$).

5. Discussion

Overall, it is observed that social activity is more frequent than cognitive activity in the three types of tasks (ACS, EW and CWQ). Furthermore, with regard to social presence, social actions (interaction and cohesion) are more frequent than affective because usually act in first phase of online learning (e.g., Swan et al., 2009). These results vary from other studies in CoI, in which the teaching presence is very active (e.g., Wicks et al., 2015). In this sense, in self-regulated CoI, social presence could compensate for the absence of teaching presence (Akyol & Garrison, 2011a,b).

Regarding cognitive presence, exploration is the most active phase, with resolution being the least active phase (almost nonexistent). Such results are typical in this type of study that used content analysis (e.g., Koh et al., 2010; Akyol & Garrison, 2011a,b; Kovanović, Gašević, Joksimović, Hatala, and Adesope, 2015).

In any case, studies using the CoI model to analyze online discussions tend to show high levels of exploration, and lower levels of integration or resolution (e.g., Akyol & Garrison, 2011a,b; Kovanović et al., 2015). Garrison et al. (2001), for example, found that the reason for this phenomenon can be found in the goal of learning and media tool functionality. In this case, the discussion forum does not record individual student activity; neither does it provide resources to facilitate the resolution of the task. Moreover, in both the ACS tasks and the CWQ tasks,

Table 5
Correlations of indicators.

	Affective	Interaction	Cohesion	Activation	Exploration	Integration	Resolution
ACS							
Affective	1						
Interaction	0.493**	1					
Cohesion	0.501**	0.704**	1				
Activation	0.196**	0.327**	0.484**	1			
Exploration	0.392**	0.378**	0.333**	0.375**	1		
Integration	0.107	0.354**	0.324**	0.160(*)	0.266**	1	
Resolution	0.234**	0.301**	0.326**	0.063	0.215**	-0.011	*1*
EW							
Affective	1						
Interaction	0.677**	1					
Cohesion	0.610**	0.751**	1				
Activation	0.568**	0.463**	0.462**	1			
Exploration	0.355**	0.565**	0.514**	0.424**	1		
Integration	0.164(*)	0.451**	0.474**	0.223**	0.333**	1	
Resolution	-0.040	0.046	0.120	-0.006	0.056	0.311**	1
CWQ							
Affective	1						
Interaction	0.783**	1					
Cohesion	0.553**	0.723**	1				
Activation	0.519**	0.630**	0.561**	1			
Exploration	0.586***	0.726**	0.565**	0.538**	1		
Integration	0.133	0.204**	0.417**	0.278**	0.191**	1	
Resolution	0.050	0.068	0.246**	0.206**	0.039	0.345**	1

* $p < 0.05$.
** $p < 0.01$.

exploration activity is especially prevalent. For example, in the ACS, students have to devote considerable time to know the details of the real case. Also, for the CWQ, students have to find out themselves how this educational resource is developed and find reference models before creating it.

It is generally observed that increasing the level of requirement of the task (in Bloom's taxonomy), also increases the frequency of online social activity. However, with regard to the cognitive activity this trend does not occur. Specifically, when students perform the ACS task, there is more cognitive activity than performing the EW task. This is consistent with research that suggests that discussion based on case studies is one of the best teaching strategies identified in the literature (e.g., Hsu, 2004; Richardson and Ice, 2010). In this study, although the ACS task mainly has an analytical nature, it also has a creative component (proposed solutions) that makes it cognitively more complex than the EW task. For example, Richardson and Ice (2010), comparing cognitive activity and academic task type using a model similar analysis to the CoI, found that the discussion based on real cases can stimulate more critical thinking than other types of tasks, such as a theoretical study or debate. It should also be noted that these case studies showed a remarkable creative component because students had to build solutions to the real problem raised.

The CWQ task is the most stimulating group cognitive activity, followed to a lesser extent by the ACS task. These high levels of social and cognitive activity in the CWQ task are consistent with the nature of this task. Creating a WebQuest can be equated with project-based learning, since this task requires students to be involved in the exploration and development of solutions (in this case, a tool for information-training for drug prevention) (e.g., Koh et al., 2010). Furthermore, these results are similar to those found in similar learning contexts. Also, Koh et al. (2010) comparing the cognitive activity between project-based tasks and nonproject-based tasks found much more cognitive activity occurs when learning was based on projects.

The fact that in the ACS task, exploration activity is greater than in the EW task may be due to the nature of the task (Garrison et al., 2001), given that while in the ACS task the exploration phase is usually the most active (e.g., Liu and Yang, 2014). In the EW task the most active phase is integration, given the central role in criteria application in such tasks.

Finally, the strong correlation between social and cognitive presence coincides with the results of other studies in synchronous learning contexts (e.g., Wanstreet and Stein, 2011) and asynchronous (e.g., Swan et al., 2009). However, unique to the current study, the findings show that in the CWQ task, in which the learning task is less structured, the correlation between social activity and cognitive activity is greater than when students have to perform more structured tasks such as ACS or EW.

6. Conclusions

In order to optimize the learning processes of online groups in the context of higher education, the authors of this study developed a self-learning environment in LMS and discussion forums for undergraduate students. To analyze the learning processes between peers, the authors used the CoI framework. This framework identifies three factors for success in teaching/learning online experiences: social presence, cognitive presence and teaching presence. Additionally, the last three levels of Bloom's taxonomy were used, to set up three learning tasks that encourage higher-level cognitive processes (AEC, EW and CWQ). In the study discussed above, two questions were identified and addressed as follows: a) what are students' social and cognitive categories in CoI when they have to perform academic tasks of higher order cognitive complexity; and (b) how do social and cognitive actions correlate depending on the requirement of the learning task?

Regarding the first question, the study authors concluded that social participation of any nature (expressions of affection, interaction and cohesion) increased with the increased requirements for the task in online learning groups. Emotional interventions occurred less frequently, possibly because they only occurred at the beginning of the task. Social participations were also the most common, searching for interaction and group cohesion, regardless of the demands of the task.

The authors concluded that the tasks of creation in online group learning processes required a higher level of cognitive participation than other lower cognitive level tasks in Bloom's taxonomy, such as the tasks of analysis and evaluation. No remarkable differences in the level of cognitive group participation between tasks of analysis and evaluation tasks were observed, except in the amount of exploratory participation, which was far higher in the analyzing task. Generally, there is sufficient evidence to affirm that requirement of the task determines the profile of social and cognitive presence in each type of task.

Regarding the second question, strong correlation coefficients between the categories of social and cognitive presence highlight the relevance of an affective group atmosphere in carrying out academic activities. The authors believe that high correlation levels between cohesion and interaction reveal the relationship between communication that bonds participants into a cohesive group and the expression of opinions, questions, and suggestions. In general, it may be stated that affection and the sense of group members and the confidence when students comment and participate are strongly interrelated aspects. The authors also believe that the high level of correlation between activation and exploration in the creating task may be due to exchanges of opinions and points of view that help participants to clearly define the proposed project. Therefore, one might observe that the more open the task is, the greater the correlations will occur between activation and exploration categories. Moreover, the strong correlation between the categories of exploration and integration in the tasks of analysis and evaluation may be due to these tasks concluding with the integration of views and opinions proposed in the group.

Finally, the categories of integration and resolution show a strong correlation index in the evaluation and creation tasks, possibly due to the nature of these tasks, since both cases involve the development of a product (database of websites and WebQuest), which requires the previous integration of information to deliver a product that has practical value.

In any case, the content analysis in this study has shown that the requirement of the task, in the context of community of inquiry in online learning, determines the type and frequency of cognitive and social activity of the group. As a result, the findings of this study may help instructors to monitor the processes of teaching and learning in these contexts.

7. Educational implications

Content analysis of online discussions conducted through forums over three academic courses and 24 groups provided results with some practical implications, although it should be interpreted with prudence due to the limitations of the study (presented below).

First, this study highlights the importance of social presence, given its high correlational relationship with cognitive presence, especially in a self-regulated online format in which teaching presence is often very limited. In an online format, learning outcomes are highly dependent on group cohesion (Aviv et al., 2003; Yang and Tang, 2004; Tirado et al., 2012). While teaching presence was not analyzed (although it was part of the experience) in the current study, it should not be overlooked because of its influence on social and cognitive presences (Garrison, Cleveland-Innes, and Fung, 2010). In suitable communities of inquiry, the instructor provides structure in the early stages of ongoing activities and later provides more open activities (Salmon, 2004). Similarly, the instructor focusses on stimulating and guiding the team, if necessary, in the process knowledge building (problem solving, evaluation, creating materials, and so on).

This study has shown that the less structured the learning task, the more interaction and cohesion occur. For instance, in this study, students had to learn how to make a WebQuest with no instructions by the instructor and it was subsequently observed that the level of social activity and cohesion was significantly higher than when students performed more structured tasks (e.g., as ACS and EW). The findings indicate that in similar contexts, socialization and group cohesion, according to the level of the structuring of the learning task, is promoted. Moreover, the degree of complexity (according to Bloom's taxonomy) and nature of the task (Garrison et al., 2001) seems to condition the level of group cognitive activity. That is, the tasks that have a creative component typically require more cognitive activity than those that focus on the analysis and application of indicators (evaluation). Therefore, the instructor must consider the cognitive demands of the task and provide more time (cognitive interaction opportunities) when the learning task has an especially creative component. In addition, time spent on the task, activation of interaction for problem identification, exploring ideas, the synthesis of proposals, and application of solutions to real cases, depend on the nature of the proposed academic task.

8. Limitations

Several limitations are noted in this study. The first limitation is that this case study focused on three learning tasks that attempt to represent the top three levels of Bloom's taxonomy (analysis, evaluation and creation). It should be noted that examples of tasks analyzed (case study, evaluation of websites, and creating WebQuest) are not exact with regard to each respective level. Given that it is difficult to find practical examples suitable for Higher Education, representing the exact taxonomic levels is appropriate to specify learning objectives in each of the task areas (e.g., Liu and Yang, 2014). Considering that cognitive presence includes self-reflection and co-construction of knowledge (Garrison et al., 2001), for a better understanding of cognitive activity in a community of inquiry it would seem appropriate to incorporate an analysis of meta-cognition (Akyol & Garrison, 2011a,b; Bjork, Dunlosky, and Kornell, 2013) especially in online self-regulated learning environments such as those analyzed in this paper. In recent studies using the CoI model, self-regulated learning (SRL) as a central aspect to understanding the learning process in a community of inquiry has been stressed (e.g., Garrison and Akyol, 2013; Shea and Bidjerano, 2009; Shea et al., 2014; Kovanović et al., 2015). Additionally, for a more accurate understanding of cognitive presence, it is important to combine content analysis with quantitative and qualitative methods (interviews, focus group…) (e.g., Szeto, 2015) measuring self-reflection (e.g., Garrison and Akyol, 2013).

Finally, this study has shown that in an online context there are certain group behaviors that are not recorded through discussion forums. This often occurs during the resolution phase, so it will be appropriate in future studies to include other technological tools to facilitate collaborative resolution of the task and to explore relevant learning outcomes of the resolution phase (e.g., Gutiérrez-Santiuste and Gallego-Arrufat, 2014). In order to do this, it seems appropriate to use analytics learning (e.g., Siemens et al., 2011; Agudo-Peregrina, Iglesias-Pradas, Conde-González, and Hernández-García, 2014). We also consider it appropriate to consider other variables to contrast the observed activity, through content analysis, with learning outcomes (e.g., Akyol & Garrison, 2011a,b; Joksimović, Gašević, Loughin, Kovanović, and Hatala, 2015), satisfaction and self-reported values of social, cognitive and teaching activity (e.g., Garrison et al., 2010; Garrison and Vaughan, 2011; Arbaugh et al., 2008; Wicks et al., 2015). Finally, we believe that the timing factor during the process of social construction of knowledge and the social structure of the groups (through Social Network Analysis) (Wang and Li, 2007; Shea et al., 2010) will provide important inputs for regulation of the processes.

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Appendix A. Social presence coding scheme

Category	Indicator	Examples
Affective	Expressions of emotions	"This is a little confusing at first…" *(JAL_T1_GC_2013)* "I feel very lucky, Kisses ;)" *(PC_T1_GB_2012)*
	Use of humor	"Put a picture in your profile for people to know how cute you are :D" *(IRP_T1_GH_2012)* "In the end we made more than a WebQuest lol" *(VDC_T3_GH_2013)* "…because my WebQuest is quite frankly ugly XD" *(MLA_T3_GE_2013)*
	Self-disclosure	"I have had personal problems" *(FMA_T1_GE_2012)* "I did not help enough in the previous activity" *(RDG_T2_GB_2012)*
Interactive	Apology	"I am sorry, I am late =S" *(SPA_T1_GA_2012)*
	Referring explicitly to others' messages	"As our colleague said …" *(PC_T3_GB_2012)*
	Asking questions	"How can we know who are the members of our group?" *(CME_T1_GC_2012)* "How do we organize for the activity?" *(FSY_T2_GB_2012)*
	Expressing appreciation	"Thank you very much for the link" *(JPT_T3_GA_2013)*
	Expressing agreement	"Your thoughts seems very good, I agree with you" *(MPF_T3_GG_2013)* "I totally agree with your choice" *(MAB_T2_GA_2013)*
	Expressing disagreement	"I understand your position, but I do not agree" *(PZV_T3_GC_2013)* "The truth is that I see it unnecessary" *(ARG_T3_GA_2013)*
Cohesive	Inviting, suggesting	"What you think if tomorrow we send the activity …" *(BLM_T2_GD_2012)*
	(Vocatives) addressing peers by name	"Thanks Ana for offering" *(FMA_T1_GF_2012)* "Thank you very much for your interest Manuel" *(MMM_T1_GE_2012)*
	Addressing the group as we, us, our, group	"We have done an excellent job" *(TCF_T3_GC_2012)* "this is a great group" *(LLC_T1_GC_2013)*
	Communicating solely for social function	"I'm glad you're feeling better" *(MVM_T3_GH_2013)* "cheer up!" *(MDE_T2_GG_2012)*

Appendix B. Cognitive presence coding scheme

Category	Indicator	Examples
Triggering	Recognizing the problem	"We must follow some certain guidelines to do the task" *(PRM_T3_GC_2013)* "Remember that there is only one week to deliver the second activity" *(MDE_T2_GG_2012)*
Exploration	Divergence of ideas	"We need to reach an agreement" *(IRP_T1_GH_2012)* "I totally disagree, nobody deserves that" *(MCO_T1_GD_2013)*
	Exchanging ideas	"Ask about their responsibility, as a result of the problems at school" *(LAT_T1_GE_2013)*

(continued on next page)

(*continued*)

Category	Indicator	Examples
Integration	Suggestions for consideration	"Peter is a child who has a great lack of interest in the study" *(SCP_T1_GE_2013)* "I'm sharing a very good link, when I saw this video I thought about the issue that concerns us right now" *(JMH_T1_GF_2013)* "I propose to write this set of problems" *(GDP_T1_GG_2012)*
	Convergence among group members	"Just as my colleague, I totally agree that there are thousands of cases" *(MDE_T1_GG_2012)* "As you said, it is essential to make a Plan of Drug Prevention" *(SES_T2_GF_2013)*
	Connecting ideas, inference, synthesis	"The keys are education and prevention at an early age" *(AGR_T1_GA_2013)* "I joined all opinions" *(FMA_T1_GF_2012)* "In summary, we have the following tasks…"*(VDC_T3_GH_2013)*
	Creating solutions	"For example, a possible solution would be to propose extra-curricular activities" *(ZMJ_T1_GD_2012)* "I have corrected the error" *(ARG_T3_GA_2013)*
Resolution	Application to real world	"It is a good idea for people to become aware of what they really know or think they know" *(FSY_T2_GB_2012)* "The activity is completed and shared" *(CMQ_T3_GB_2013)*

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