Promoting Cognitive Presence through Asynchronous Discussions on Learning Design Tasks

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Abstract. In this paper we investigate how the design and organization of asynchronous discussion tasks may encourage participants’ reflection and cognitive development. The theoretical premises of this research lie on the Community of Inquiry (CoI) framework. In particular instructor’s design choices on the orchestration of discussion forum tasks (teaching presence) propose two forum tasks, the first for students' familiarization with asynchronous discussion processes and the second for designing a technology enhanced course (learning design task). Specific log data from both forums are correlated with data that derive from CoI qualitative content analysis reflecting each student's cognitive development through the learning design task. Results provide evidence about the value of familiarizing students with asynchronous forum processes as well as of participating in learning design tasks organized as a practical inquiry cycle in promoting cognitive development.

1 Introduction

Computer mediated communication in a teacher training context can be used to enable the implementation of reflective and dialogic approaches addressing also the problem of teacher isolation (Hathorn & Ingram, 2002). Specially, a critical issue in organizing blended training for teachers in a constructivist basis is how to orchestrate asynchronous interaction around educational goals and engage trainees in learning design processes. A well known process model of online learning is the Community of Inquiry (CoI) framework (Garrison 2011) which addresses the online interaction as a blend of three presences – social presence, cognitive presence, and teaching presence (Swan et al. 2009). In particular, cognitive presence is defined in terms of a cycle of practical inquiry comprised of four phases (Garrison 2011): (a) an initiation phase which is considered a triggering event, (b) an exploration phase characterized by brainstorming, questioning, and information exchange, (c) an integration phase focusing on meaning construction, (d) a resolution phase resulting in the resolution of the problem posed by the triggering event.

A challenging issue demanding further exploration is the progressive development of practical inquiry in an online learning environment. Research findings reveal that inquiry has great difficulty moving beyond the exploration phase (Celentin 2007; Meyer 2004; Vaughan & Garrison 2005). Concerning teaching presence,
researchers have documented strong correlations between the teaching presence and the development of a sense of community on online courses (Shea et al. 2005). In fact the body of the evidence supporting the critical importance of teaching presence for successful online learning continues to grow (Swan & Shea 2005; Vaughan & Garrison 2006) with the most recent research suggesting that teaching presence is the key to developing online communities of inquiry (Shea & Bidjeramo 2008). In addition, with respect to the teaching presence, various factors have been investigated on how the students move on the phases of the practical inquiry process such as faculty instructions (Luebeck & Bice 2005), instructor’s role (Celentin 2007; Garrison et al 2001) or the question initiated the inquiry process or the appropriated designed tasks (Murphy 2004).

Especially when a community of inquiry is considered, most studies exploring the degree of development of cognitive or teaching presence are based on data from questionnaires (such as CoI survey (Arbaugh et al. 2008)) or CoI qualitative content analysis (Garrison et al. 2000). A new approach recently proposed by (Shea et al. 2010) analyses system log data adopting social network analysis methods. This approach has much to benefit from research in the area of internet communities where various sets of metrics have been proposed in order to assess the engagement of the members within the community (Koohang et al. 2010). Some of the most representative metrics include the traffic among the members, the sessions to which the members are engaged and a scoring about the influence of their involvement (Qian et al. 2014). The metrics estimated for student communities can also provide valuable information on the assessment of factors like teaching, cognitive and social presence of the class.

In this paper we investigate how teaching presence can affect students' cognitive development at a learning design task in the context of a course on Technology Enhanced Learning (TEL). These students are considered as pre service teachers undertaking a project of designing a technology enhanced course for their students using several pedagogical and technological tools and working in groups. In this project the main communication tool of the groups and the class is the asynchronous forum. Especially, we consider the design & organization category of teaching presence (Garrison 2011) that, in the approach proposed, includes actions like the sequencing of asynchronous discussion tasks, and the provision of complementary learning content accompanying the particular tasks. To evaluate this approach, we correlate specific log data from students' asynchronous interaction with content and peers with data that derive from CoI qualitative content analysis of the messages exchanged through the learning design task. CoI qualitative data reflect each student’s cognitive development. In particular, we focus on the following research questions:

**Research Question 1:** Can students' familiarization with asynchronous discussion processes through an introductory discussion task affect the cognitive presence development of students in a learning design task?

**Research Question 2:** Can participation in a learning design task organized asynchronously (quantitative data) be related to students’ cognitive presence development (qualitative data)?

### Asynchronous Forum Discussions In a Pre-service Teacher Training Course on TEL

In (Papanikolaou et al. 2014) we proposed a design rational for constructivist pre-service teacher training on TEL, based on a view of teachers as designers of innovative content working individually and collaboratively, discussing and interacting with the instructor and their peers. Throughout the course, students work individually and in groups, and communicate through asynchronous Forums, beyond the class time. Especially asynchronous Forum interaction is organized in two stages: (a) at the first stage an introductory activity is proposed asking each student to comment on specific advantages and disadvantages of various WebQuests (Forum 1) and (b) then at a next stage students working in groups used the asynchronous Forum (Forum 2) in order to discuss the design and implementation of a technology enhanced course which was comprised by discrete learning activities of various types (Laurillard 2012) integrating digital resources and objects developed with Web 2.0 technologies, aiming at various knowledge processes based on the New Learning framework (Kalantzis & Cope 2012). Trainees were encouraged to participate in Forum 1, whilst participation in Forum 2 was mandatory.

The above rationale guided a six-month course on TEL, provided by ASPETE in the context of a graduate certificate in Informatics at the Technological Educational Institute of Central Greece. The course took place between September 2013 and January 2014 with 80 students. The course builds on participants’ content knowledge as it is their third year of specialization in Informatics.

### Data Collection and Analysis
In order to address the research questions, we used quantitative data from Forums 1 and 2 as well as qualitative data from Forum 2 resulting from analyzing messages exchanged in the particular forum. The quantitative data relate to the students' participation in Forum 1 and their behavior in Forum 2. Specific metrics were calculated on log data of Forum 2 which reflect students' participation in the community and study behavior. Qualitative content analysis of students' messages in Forum 2 was also performed by two instructors who were also experts in Coi content analysis. The Forum 1 discussion task lasted for two weeks and it comprised of 69 messages whilst Forum 2 lasted for one and a half month and it comprised of 413 student cognitive messages. In the following paragraph, the metrics calculated are presented.

**Quantitative analysis.** For students' involvement in the introductory asynchronous discussion task of Forum 1, we only considered if they participated or not, organizing students in two groups: students belonging in Group 1 are those who got involved both in Forum 1 and Forum 2 task, whilst students belonging in Group 2 are those that got involved only to Forum 2 task.

Concerning Forum 2, several types of log data were gathered for each student reflecting his/her involvement in the particular discussion task. For students' involvement in Forum 2, we considered the following metrics:

- **Student participation** in the discussion is calculated by:
  \[
  s_{\text{participation}} = a \times \text{forum_view_threads} + b \times \text{forum_view_discussion} + c \times \text{forum_add_post}
  \]  
  where:
  - (a) forum_view_threads: factor reflecting how many times a student has viewed the Forum threads,
  - (b) forum_view_discussion: factor reflecting how many times a student has viewed the discussion Forum,
  - (c) forum_add_post: factor reflecting how many times a student has added a post.

  The a, b, c weights reflect each factor's importance for the particular task.

- **Student study** of learning content through the discussion is calculated by:
  \[
  s_{\text{study}} = a \times \text{folder_view} + b \times \text{resource_view} + c \times \text{url_view}
  \]  
  where:
  - (a) folder_view: factor reflecting how many times a student has viewed a specific folder with learning content,
  - (b) resource_view: factor reflecting how many times a student has viewed a specific type of learning content,
  - (c) url_view: factor reflecting how many times a student has visited a web resource offered.

  The a, b, c weights reflect each factor's importance for the particular task. This is due to the fact that there are various types of learning content, a) notes and presentations about pedagogical issues like WebQuest design principles and learning by design notes, which are located in folders, b) resources such as web 2.0 manuals and finally c) web resources like URLs of specific WebQuests.

**Qualitative analysis.** The messages of Forum 2 were initially analysed and characterised based on the practical inquiry phase they belong to. The unit of analysis was the message, so each message was characterized as belonging to only one phase. As the instructor initiated the discussion providing the triggering event (initial phase of the discussion), the students' messages could belong only to one of the rest three cognitive presence phases. Then we calculated the percentage of messages exchanged in Forum 2 at each of the three practical inquiry phases of cognitive presence. From this analysis we resulted to four metrics reflecting students' cognitive presence development: 1) contribution to exploration: the percentage of messages posted by a student and belong to phase 2 (exploration), 2) contribution to integration: the percentage of messages posted by a student and belong to phase 3 (integration), 3) contribution to resolution: the percentage of messages posted by a student and belong to phase 4 (resolution) 4) cognitive progress reflecting the student's level of development from the second phase of exploration until the final phase of resolution taking the following values: (a) Level 1: The student’s messages belong only to exploration or integration phase, (b) Level 2: The student’s messages belong to two discrete phases showing that s/he moved from one phase to another such as from exploration to integration or from exploration to resolution (without posting messages that belong to integration phase) or from integration to resolution, (c) Level 3: The student’s messages belong to three phases showing that s/he moved from the exploration to the integration and then to the resolution phase.

**Results**

Research Question 1: Can students' familiarization with asynchronous discussion processes through an introductory discussion task affect the cognitive presence development of students in a learning design task organized asynchronously? Analyzing Forum 1 log data, we came up with two groups of students, those who
participated in Forum 1 (Group 1) and those who didn't (Group 2). Aiming at investigating whether there was any difference between the two groups of students, a two-way analysis of variance (ANOVA) for mixed design was performed on the following dependent variables:

1. contribution to exploration variable for phase 2 of cognitive presence,
2. contribution to integration variable for phase 3 of cognitive presence,
3. contribution to resolution variable for phase 4 of cognitive presence

The difference between the two Groups on the cognitive progress dependent variable was not calculated because this was an ordinal variable.

Initially, from the means plot of the variables (Fig. 1) it is obvious means vary between the two different groups of data (Group 1 and Group 2). Fig. 1 presents a statistically significant interaction between students’ involvement in Forum 1 and the three types of their contribution, which was also demonstrated by the two-way ANOVA, \[ F(2, 138)=3.31, \ p=.04, \eta^2=.046 \]. In particular, involvement in asynchronous discussion task has the opposite effect between Group 1 and Group 2 for the three types of contribution. Concretely, Group 2 has achieved higher contribution to the exploration phase than Group 1, but as far as its contribution to integration is concerned, this has considerably lower levels than the relative contribution of Group 1. The same stands for the resolution phase although with lower values. This makes Group 1 looks like a more mature group in the discussion process.

**Fig. 1.** Means plot shows means of contribution to exploration, integration and resolution for Group 1 and Group 2

Then, in order to break down this interaction between the IVs, the simple main effects were calculated. Specifically, three one-way ANOVAs were performed on each of the three types of students’ contribution at Forum 2, testing the effect of involvement in the introductory discussion task of Forum 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean Group 1</th>
<th>Mean Group 2</th>
<th>Std. Deviation Group 1</th>
<th>Std. Deviation Group 2</th>
<th>F</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to exploration</td>
<td>.2680</td>
<td>.4015</td>
<td>.33111</td>
<td>.16187</td>
<td>F(1, 69) = 5.17</td>
<td>p = .03</td>
</tr>
<tr>
<td>Contribution to integration</td>
<td>.3855</td>
<td>.2711</td>
<td>.33865</td>
<td>.36175</td>
<td>F(1, 69) = 1.75</td>
<td>p = .19</td>
</tr>
<tr>
<td>Contribution to resolution</td>
<td>.2036</td>
<td>.1789</td>
<td>.30977</td>
<td>.35234</td>
<td>F(1, 69) = .90</td>
<td>p = .77</td>
</tr>
</tbody>
</table>

**Table 1.** One-way ANOVA results for students’ involvement in Forum 1 discussion task

Based on the results appearing in Tab. 1, a significant effect of students’ involvement in Forum 1 on Contribution to exploration in Forum 2 was observed with Group 2 having higher contribution. There was not a significant effect of students’ involvement in Forum 1 task on a) student Contribution to integration and b) student Contribution to resolution in Forum 2 (p > .05). Concluding, although there is not statistically significant difference between the two Groups to Contribution to integration or resolution, the interaction between the two Groups that has been earlier observed, provides important evidence about the potential of Group 1 over Group 2 in promoting its students' cognitive development.
Research question 2. Can participation in a learning design task organized asynchronously (quantitative data) be related to students' cognitive presence development (qualitative data)? To answer this question we calculated Pearson correlation coefficients in order to correlate the quantitative variables of Forum 2 reflecting students' behaviour affected by teaching presence (s_study and s_participation variables) to qualitative ones reflecting student contribution to the practical inquiry phases (contribution to exploration, contribution to integration, contribution to resolution variables).

Then we calculated Spearman’s rho correlation coefficients in order to correlate the quantitative metrics of Forum 2 (s_study and s_participation variables) to qualitative ones reflecting cognitive progress. The calculation of Pearson’s correlation coefficients revealed: (a) a significant medium positive correlation between student participation in Forum 2 (s_participation variable) and contribution to resolution in Forum 2 variable (r=.45, p<.001), (b) a statistically significant but weak positive correlation between student participation in Forum 2 and Contribution to exploration (r=.27, p<.05) and (c) a statistically significant but weak positive correlation between Forum 2 participation and Contribution to integration (r=.24, p<.05), (d) statistically significant positive correlations between student study in Forum 2 (s_study variable) and Contribution to exploration (r=.30, p<.05), student study in Forum 2 (s_study variable) and Contribution to integration (r=.31, p<.05) and student study in Forum 2 (s_study variable) and Contribution to resolution (r=.28, p<.05).

Correspondingly, the calculation of Spearman’s rho correlation coefficient revealed: (a) statistically significant positive and large correlation between the student study in Forum 2 study (s_study variable) and the cognitive progress variable (Spearman’s rho (71) =.68, p<.001) and (b) statistically significant positive and medium correlation between the student participation in Forum 2 participation (s_participation variable) and the students' cognitive progress (Spearman rho (71) =.57, p<.001).

It is quite encouraging that quantitative data are significantly correlated with qualitative data. In particular, it is worth noting that participation to the learning design discussion task is medium correlated to contribution to resolution which is the most demanding phase of the practical inquiry cycle. Moreover, the high correlation of cognitive progress with the participation and study variables provide evidence about the importance of students' active involvement in the learning design discussion task (in terms of posting messages, viewing peers' messages but also study of various types of content) in their cognitive development according to the Community of Inquiry model.

Conclusions and Discussion

In this paper we elaborated on orchestrating asynchronous discussions aiming at (a) familiarizing the target group with different forms of online interaction such as: student-to-whole class, student-to-tutor, inter-group, intra-group, (b) promoting the practical inquiry process on learning design processes. Aiming at investigating the added value of such an orchestration we acknowledged two groups of students, those that participated at the introductory discussion task (Group 1) and those that didn't (Group 2). Actually, we resulted that each of these groups has considerably different contribution to the various phases of the practical inquiry process reflecting students' cognitive development. Especially, we observe that students of Group 2 have significantly higher contribution to exploration but they have lower results than the students of Group 1 to the integration and resolution phases. This clear trend should be further investigated in various learning contexts. Results provide evidence about the potential of teaching presence and especially of the design and organization of asynchronous forum tasks, as an important factor affecting students' cognitive presence development. Such design decisions can impact students' cognitive presence development both at community and individual level. In our case we examined community's cognitive presence by means of individual metrics. Various log data coming from students' interaction (with content or peers) through a discussion task were used to assess the individuals' cognitive development along with qualitative data coming from content analysis. The development of such metrics is worth noting that may have a significant value for the assessment of the individuals' cognitive development within the community. This is an issue that worth to be further explored.

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