The Effects of Visible-Annotation Tool on the Learning Process and Learning Outcome in CSCL

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Abstract

This study was designed to investigate how representation tool types, designated "visible annotation", facilitate the learning process and enhance learning outcomes in CSCL environments. Twenty-eight students participated in this study, and they were divided into two groups: the TLL-type focusing on defining the concept of learning contents and the CTLL-type focusing on discussing the concept of learning contents. The result indicated that TLL-type was more effective in both the learning process and learning outcome.

Introduction

Computer-supported collaborative learning (CSCL) is a learning method that facilitates collaborative learning using computers and networked devices (Schwarz, Groot, Mavrikis, & Dragon, 2015; Stahl, 2015). Some CSCL researchers have reported that CSCL is more effective than face-to-face learning because it can help learners overcome the limits of physical space using computational devices (Fischer, Bruhn, Grasel, & Mandl, 2002; Pena-Schaff & Nicholls, 2004; Schellens & Valcke, 2006). Learners carry out complex task through sharing each other's knowledge, negotiating various opinions, and integrating different perspectives in CSCL (Eryilmaz, van der Pol, Ryan, Clark, & Mary, 2013). It is effective for enhancing individuals' knowledge construction and achieving a higher-level of collaborative knowledge construction (Garrison & Arbaugh, 2007; Morgan, Whorton, & Gunsalus, 2000). However, in the process of achieving higher-quality solutions, many restrictions can be imposed due to the learners' diverse perspectives in such areas as sharing problem awareness, negotiating a variety of opinions, and building collaborative knowledge based on communicative activities (Fuks, Pimantel, & Lucena, 2006). In addition, collaboration load can occur in CSCL environments, and this can lead to ineffective learning processes and unsuccessful learning performance. Most previous research showed that representation tool can support learners' construction of accurate shared knowledge and a higher level of constructed knowledge focusing on learning outcomes (Fuks et al., 2006). However, few efforts explored the impact of learning performance on the sequential process of knowledge construction requiring various interaction types according to the nature of the complex task.

This study was designed to investigate how representation tool types, designated "visible annotation," facilitate the learning process and enhance learning outcomes in CSCL environments. Based on the principle of collaborative knowledge construction, we developed the following two types of visible annotations with a linked annotation function: the TLL-type, representing the one meaning-sharing learning phase focusing on defining concept of learning contents and one opiniont-sharing learning phase used to build shared knowledge (TLL); and the CTLL-type, representing the one meaning-sharing learning phase focusing on discussing concept of learning contents and one opinion-sharing learning phase used to build shared knowledge (CTLL). The two visible-annotation types include the same problem-solving learning phases used to build constructed knowledge.

Specifically, the following research questions were addressed in this study. First, what are the effects of the visible-annotation tool on the learning process in the CSCL environment? Second, what are the effects of the visible-annotation tool on the learning outcome in the CSCL environment?

Theoretical Background

Collaborative learning is effectively carried out if there are active interactions between team members in CSCL environment (Kolloffel, Eysing, & de Jong, 2011). However, if the number of unshared messages among the learners grows, collaborative interaction is replaced by simple interaction, and this does not positively influence shared knowledge building and collaborative learning outcomes (Suthers, Vatrapu, Medina, Joseph, & Dwyer, 2008). To facilitate meaningful interaction in CSCL, researchers have designed and developed a variety of tools (Kolloffel et al., 2011). Especially, many strategies using representation tools have been verified that specific functions (e.g., concept map, graph, matrix, and annotation) can induce active interaction within learners and acquire high-quality of learning outcomes by visualizing learners' cognitive process (Bell, 1997; Bruggen, Kirschner, & Jochems, 2002; Schwarz et al., 2015). Recently, Eryilmaz et al. (2013) showed that linked-annotation function based on asynchronous discussion can facilitate interactions of conflict and assertion, which is related to the effects of supporting the "negotiation of position" phase (Beers, Kirschner, Boshuizen, & Gijselaers, 2005, p. 10). However, they fail to verify to effects of supporting the "negotiation of meaning" phase such as interactions of clarification, interpretation (Beers et al., 2005, p. 10).

As Beers et al. (2005) and Rummel and Spada (2005) indicated, meaningful interaction in CSCL requires a series of phase from unshared knowledge to collaborative knowledge through several sharing activities. In particular, the optimal learning methods for each learning phase should be applied when carrying out the sequential sharing activities of learning content from the key concept to more complex learning content (Cannon-Bowers & Salas, 2001). The exact meaning sharing of learning content in an ill-structured task can help learners reduce the possibilities for misunderstanding and lead them to in-depth discussions (Slof, Erkens, & Kirschner, 2011). Considering the importance of exact meaning sharing in a knowledge construction process for the complex task (Beers et al., 2005; Jorczak, 2011; Rummel & Spada, 2005), Shin, Kim & Jung (in press) suggested the representation tool adapting different types of represenation function. Specifically, learning process consisted of three phases based on nature of part-tasks and the process of collaborative knowledge construction; meaning sharing, opinion sharing, and problem-solving. The result revealed the meaningful effectiveness on the accuracy of sharing activities and level of collaborative performance (Shin et al., in press). However, the finding has still a limitation because it could not deeply catch interaction patterns occurring each sharing phase (Fu, Aslst & Chan, 2016; Yücel & Usluel, 2016).

Although recent researches have been conducted to analyze qualitative dialogue, they rarely analyzed results systematically by considering theoretical principle (Fuerstenau, Ryssel, & Kunath, 2010; Schellens & Valcke, 2005; Yücel & Usluel, 2016). The recent research of the analyzing discussion patterns has reported that much research has shown a noticeable problem that fails to consider interaction pattern both theoretically and practically to promote various collaborative interaction activities (Fu et al., 2016). To overcome this limitation, the present study aims to deeply explore the sequential knowledge construction process by using representation tool reflecting knowledge construction principle.

Method

To test the hypotheses, this study analyzed the online messages posted on an asynchronous discussion tool (Visible-annotation) that was used as a learning environment. As a reflecting limitation of previous researches, this paper focused on the analysis of the knowledge construction process more deeply. Moreover, this study tries to explore the process of interaction in relation to the collaborative learning outcome.

Procedure

The experiment was conducted as a three sub-tasks for four weeks in an online learning environment without a face-to-face meeting. The participants first performed pre-test which consisted to prior knowledge, computer literacy, collaborative tendency, and was provided with the manual included to learning tasks and method of using the tool. The students participated in pairs in the experiment. All of the groups performed sub-tasks through same material related to educational methodology. However, there was a difference of annotation type. Specifically, sub-tasks consisted of core-concept understanding and sharing of learning material, specific-content sharing of learning material, and lesson planning task. Students were asked to submit a lesson planning in pairs at the end of collaborative learning (see *Figure 1*).

1) Pretests	2) Meaning sharing	3) Opinion sharing	4) Problem solving	5) Collaborative outcome test

Figure 1. Learning processes

The Compared Tools for Analyzing Other Treatment

To compare the effectiveness of treatment, the different two types of visible annotations were used. The tool of CTLL type was considered managing strategy for the type of tool, which has two times sharing activities through sentence-based annotation only (see *Table 1*).

Table 1. Learning phases and learning methods based on visible annotation types

<table>
<tr><th rowspan="2">Visible annotation type</th><th colspan="2">Sharing phase
Comprehension of learning content task</th><th>Problem-solving phase
Lesson planning task</th></tr>
<tr><th>1st week</th><th>2nd week</th><th>3rd & 4th week</th></tr>
<tr><td>CTLL</td><td>Meaning sharing learning phase
1) Sub-task
- To define the meaning and explain of core-concept of material
2) Function of tool
- Sentence-based annotation
- Linked annotation</td><td>Opinion sharing learning phase
1) Sub-task
- To ask, submit of opinion and comment on specific content of material
2) Function of tool
- Sentence-based annotation
- Linked annotation</td><td rowspan="2">Problem-solving learning phase
1) Sub-task
- To negotiate various opinions and derive solutions for completing the lesson-planning task
2) Function of tool
- Sentence-based annotation
- Linked annotation</td></tr>
<tr><td>TLL</td><td>Meaning sharing learning phase
1) Sub-task
- To define the meaning and explain the pros & cons of core-concept of material
2) Function of tool
- Word-based annotation
- Linked annotation</td><td>Opinion sharing learning phase
1) Sub-task
- To ask, submit of opinion and comment of specific content of material
2) Function of tool
- Sentence-based annotation
- Linked annotation</td></tr>
</table>

Interaction Analysis of Knowledge Construction Activities

We investigated the frequency and proportion of discussion activities in each group. The messages were analyzed by Pena-Shaff and Nicholls (2004) sentence analysis tool. Three educational experts reviewed and used content validity. The level of inter-rater reliability was .78.

Analysis of Collaborative Learning Outcome

The learning outcome was measured by the lesson-planning task. A three-point Likert scale was developed to measure the level of the constructed knowledge, based on the research of Dick, Carey, and Carey(2003), and Gagné, Wager, Golas, and Keller (2005).The level of inter-rater reliability of three evaluators is .89.

Results

This study carried out the sequential analysis based on the quantitative content analysis results. Annotations coded by the scheme were organized chronologically. The circles in following figures represent knowledge construction activities. The arrows between circles depict directed transitions. The thickness of an arrow is proportional to the probability of a transition. The values specified in the figures illustrate transitional probabilities. To ease readability, transitional probabilities less than 0.30 were omitted in the figure. Also, we investigate the z-score which take into account not only the observed total number of responses to a particular messages category but also the marginal totals of each response type observed across all message types (Jeong & Frazier, 2008).

Meaning Sharing Phase

First, in the CTLL type, sequential analysis results of interactions in meaning sharing phase showed a pattern that almost activities such as interpretation, question, assertion, and support were converged to clarification. However, the result of z-score was only statistically significant in patterns from clarification to clarification (z = 2.78, p <.01). On the other hand, despite the small cell frequencies, there was significantly higher than expected from conflict to question (z = 7.84, p <.01) (see *Figure 2*). Next, in the TLL type, all seven activities in meaning sharing phase were converged to clarification activities. And there were statistical significant results of z-score from clarification to clarification (z = 2.78, p <.01), from Interpretation to interpretation (z = 9.19, p <.01), from question to clarification (z = 1.81, p <.05), and from assertion to clarification (z = 2.19, p < .05) (see *Figure 3*). The interaction patterns of two groups were similar to those of clarification, but TLL type was differed in that they have significant z-score with various activities. In the case of CTLL type, a pattern from conflict to question, which is expected to be derived from the opinion sharing phase, was derived at the meaning sharing stage.

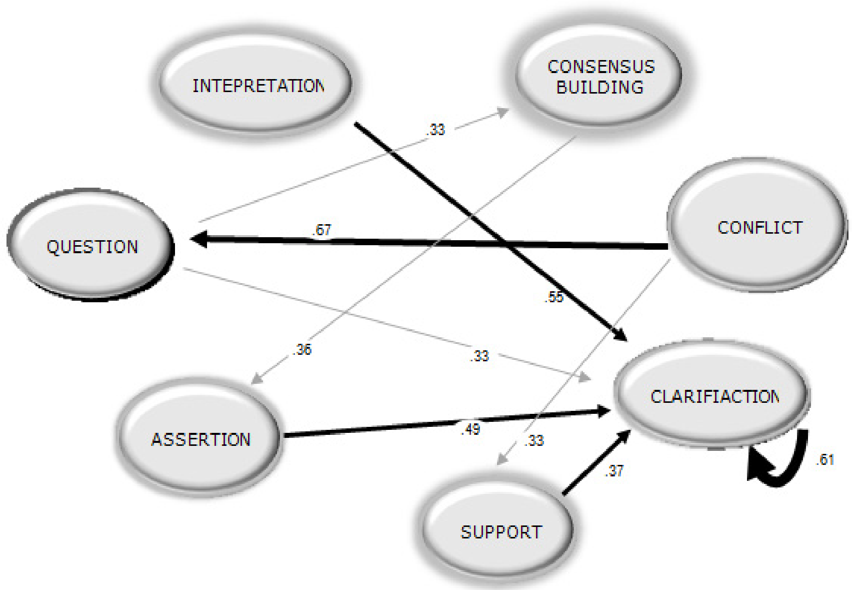

Figure 2. Transitional state diagram for meaning sharing phase of the CTLL type

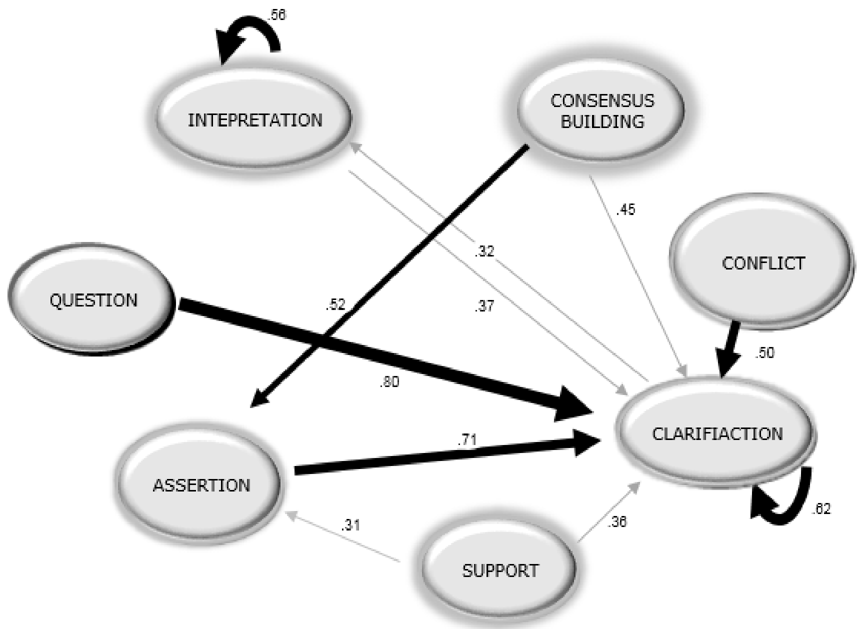

Figure 3. Transitional state diagram for meaning sharing phase of the TLL type

Opinion Sharing Phase

First, in the CTLL type, the sequential results of interaction showed a pattern that converged to the assertion. Moreover, z-score of sequential analysis was only statistically significant in patterns from assertion to assertion (z = 5.38, p < .01). On the other hand, there was significant result from clarification to clarification (z = 7.55, p <.01), and from interpretation to interpretation (z = 5.90, p <.01) (see *Figure 4*). Similar to results of the CTLL type, the sequential pattern in TLL type was also converged to assertion activities. Specifically, there were statistical significant result of z-score from assertion to assertion (z = 3.14, p < .01), from clarification to interpretation (z = 4.43, p < .01), and from interpretation to interpretation (z = 4.66, p < .01) (see *Figure 5*). In conclusion, in the opinion sharing phase, two groups had similar patterns to the interaction, unlike the meaning sharing.

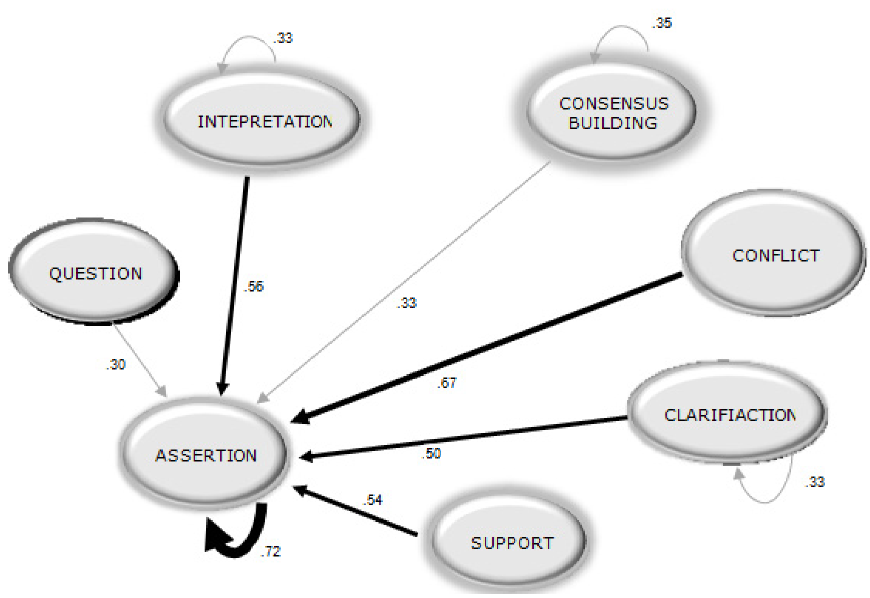

Figure 4. Transitional state diagram for opinion sharing phase of the CTLL type

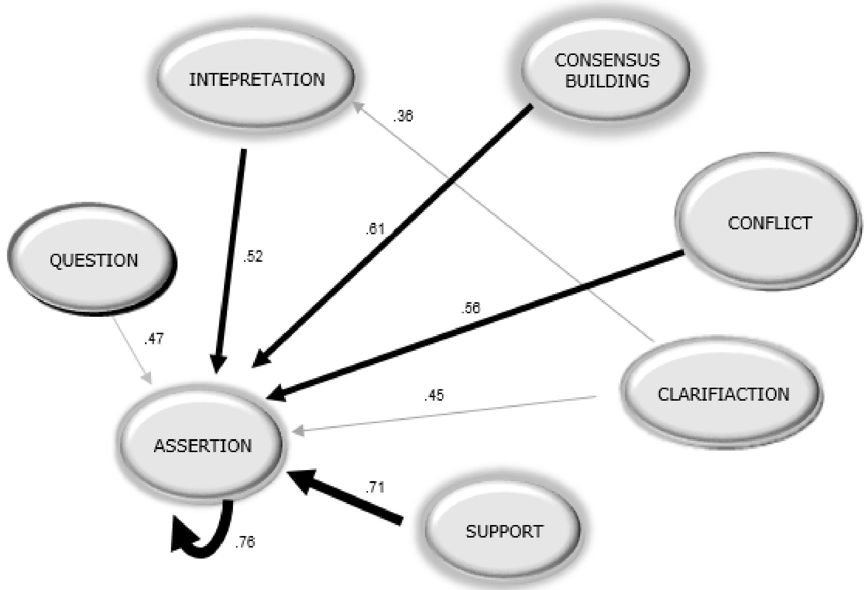

Figure 5. Transitional state diagram for opinion sharing phase of the TLL type

Effects of Types of Tool in Learning on Collaborative Learning Outcomes

The results of ANCOVA of the constructed knowledge found significant differences between conditions *[F (1, 23) = 8.59, p = .008]*. The level of collaborative learning outcome in the TLL type condition *(M=10.86, SD=1,49)* was higher than the level in the CTLL type condition *(M=8.04, SD=2,72) (*see *Table 2)*. The results implied that the concept sharing phase of the learning content could affect the level of the collaborative learning outcome.

Table 2. Effects of types of tool on collaborative learning outcomes measures

Types of tool	*M*	*SD*	*AM*
CTLL	8.04	2.72	8.07
TLL	10.86	1.49	10.83

N=28. M=Mean. SD=Standard deviation. AM=Adjusted mean.

Conclusions

The results were consistent with the empirical evidence for the knowledge construction principle previously obtained in CSCL research (Beers et al., 2005; Rummel & Spada, 2005). The TLL focusing on concept learning was found to more effective in learning process and learning outcome. Specifically, TLL-type facilitates clarification and interpretation activities for help understanding about learning content, and these activities lead to assertion activities that enhance the quality of ill-structured problem-solving. However, lower activities occurred in TLL than CTLL, such as consensus and conflict activities, should be explored with re-analysis.

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