Facilitating constructive online discussion using graphical representation

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This study examined the effects of comment styles and visual representations on discussion activities. Eighteen students were recruited from a university and participated in discussion for four weeks in three conditions: *General Comment, Interaction Diagram, and Topic Diagram*. The *General Comment* received comments on discussion topics without visual representation, while other two groups received comments and diagrams related to their interactivities (interaction diagram) or discussion flows (Topic Diagram). The result showed that students in the *Interaction Diagram* posted more messages than other groups. About the quality of discussion, however, those in the *Topic Diagram* generated more qualified arguments than others. These results demonstrated the potential benefits of representative comments on discussion topic and interactivities.

Introduction

Discourse in scientific inquiry and reasoning is a primary way to construct knowledge (Kuhn, 1993). Discussion activities using an online discussion board are very common instructional strategies that allow students to share ideas and develop knowledge (Wu & Hiltz, 2004). Some researchers maintain that computer conferencing provides a collaborative learning environment, enhances divergent thinking, and, in turn, builds networked learning communities (e.g. Harasim, 1990). Despite these apparent benefits, students are reluctant to engage in knowledge construction. Students are satisfied to share resources and fail to elaborate their thoughts. Many studies on online discussion have revealed that dominant interactions among students were limited in sharing information without knowledge construction, critiques on peer ideas, or negotiation (Gunawardena, Lowe, & Anderson, 1998; Heckman & Annabi, 2005; McLoughlin & Luca, 2000). To make matters worse, students who remain at a basic level of participation and interaction consolidate their current insufficient knowledge and do not tests exist concepts or reconstruct new mental models (McLoughlin & Luca, 2000).

Why do not students engaged in higher order thinking and fail to construct knowledge in academic discussion? The phenomenon can be explained by contrasting insufficient skills and knowledge with demanding tasks. Participation in discussion requires cognitively challenging activities such as building explanations, evaluating other claims, and accommodating conflicting arguments. Even adult learners have difficulty constructing warranted and qualified argumentative discussions (Kuhn, 1991). Moreover, students have to interpret others' arguments correctly and evaluate them. To construct knowledge through discussion, they also need to hold the flow of discussion. Given insufficient ability, discussion activities may be too cognitively demanding to allow students to focus on new knowledge construction.

Group norm or accountability of members can also affect discussion activities. Discussion is not individual work but rather collaborative, requiring the input of each member. Thus, students have to share their ideas and mutually engage in constructing warrant arguments. However, students tend to follow group norm: unwritten rules shared with group, which hinder generating critical or exploratory arguments (Janssen, Erkens, & Kanselaar, 2007; Jeong & Joung, 2007). Therefore, coordination of discussion activities is required in order to achieve common goals through monitoring and evaluating those activities.

To support cognitive and metacognitive demands, instructors' discussion management strategies are important (Mazzolini & Maddison, 2003). The most common way to facilitate discussion is to provide comments on students' messages. However, the effects of comments on constructive knowledge building in collaborative online discussion have not been revealed. In addition, there are many questions unanswered: how do we scaffold student's metacognitive skills in an online discussion? Do instructor's comments encourage students to use metacognitive skills to manage online discussions? Although many studies emphasize the important roles of mentors and peers, they have failed to show empirical results of implementations (e.g. Salmon, 2000).

The current study investigated the effects of graphical representations as instructors' discussion scaffolding comments. Practically, the study would suggest how instructors can facilitate meaningful discussions through the illustrations of discussions. Theoretically, the

study would reveal the role of graphical representation in collaborative knowledge building process.

Prerequisites for Collaborative Knowledge Building in online discussion

Interactivity

Research on peer learning (e.g. Cohen, 1994; Webb, 1982) has shown that peer interaction influences the cognitive activities and affects learning performance. Cohen (1994) summarized useful interaction types according to the nature of tasks: for conceptual learning a "mutual exchange process," in which ideas, hypotheses, strategies, and speculation are shared, is recommended, while "helping each other" to understand learning materials or lectures by offering substantive and procedural information is recommended for routine learning. Webb (1982) found that "giving help" and "receiving help" types of interaction were positively related to learning outcomes while "off-task" and "passive behavior" types were negatively related to achievement. Especially when a task was complex, requiring integration or reorganization, requiring students to explain ideas to peers was more beneficial to the explainer. From these studies we can argue that learners may be encouraged to engage in higher-order cognitive process by appropriate peer interactions.

Unfortunately, many studies (Pressley, McDaniel, Turner, Wood, & Ahmad, 1987; Webb, Ender, & Lewis, 1986) revealed that these kinds of constructive interactions do not occur spontaneously. Cohen (1994) suggested that interpersonal skill and specific skills for discourse were required to cultivate high level operations in cooperation, however, these skills "are not an automatic consequence of cooperative learning" (p. 7).

From these studies, we can draw a general inference that the appropriate interactions among peers is critical to construct knowledge in online collaborative learning environments. These interactions can be cultivated by direct instruction or structured

interaction guidance. The role of an instructor as a facilitator cannot be ignored in successful learning.

Metacognitive representation

In the online discussion, learners are supposed to share their thought through written communication tools and apprehend other's messages. There are several meaningful trials that support learner cognition and metacognition, such as providing diagrams of arguments (Nussbaum, Winsor, Aqui, & Poliquin, 2007); guidance of peer questioning (Choi, Land, & Turgeon, 2005); and training metacognitive skills (Paris & Winograd, 1990). For example, Belvedere, "networked groupware for constructing representations of the logical and rhetorical relations within a debate", was developed for the purpose of supporting the practice of critical discussion (Suthers & Weiner, 1995). It provided learners with visual tools representing the abstract components and their relationship in arguments. Since Belvedere was intended to encourage learners to draw their own diagram, it helped them express their thoughts in an argument graphic. Further studies have revealed that more knowledge construction took place when learners were supported by visual representation (e.g. Suthers, Vatrapu, Medina, Joseph, & Dwyer, 2007). Suthers (2001) suggested that representational support for conceptual structures helped learners to address issues of coherence and convergence in group work and supported collaborative knowledge construction in an online learning environment.

Jeong and Joung (2007) examined the effect of message constraints and message labels on scaffolding collaborative argumentation in asynchronous discussions. They used message constraints and labels as a means to operationalize messages by restricting each message to serve only one function at a time, such as argument, evidence, critique, and explanation. The restriction was expected to increase visibility of critical responses resulting from label in the title and it helped students sustain and advance discussion threads (Hewitt & Teplovs, 1999). Although they expected the use of message constraints and labels produced meaningful message-response sequence illustrating high levels of argumentation, the results showed that the methods hindered learners from generating

critical responses such as challenging others' argument. The label identifying critiques discouraged learners from posting critiques.

These studies suggest that the quality of online discussions rely on interactivity and metacogntive representation, and, therefore, a graphic representation illustrating discuassion interaction would have an effect on facilitating learners' engagement. Considering the importance of metacognition in group discussions, conceptual representation may enhance learners' higher-order thinking, and, in turn, facilitate knowledge building.

In the current study, two visual supports and three comment strategies were tested. Depending on the type of instructors' comments and visual support, learners' discussion pattern and quality should be different. Thus, in this study the following questions were examined.

- Do visual supports and comment types affect students' interaction in online discussion?
- Do visual supports and comment types affect the quality of online discussion?

Method

Participants and Design

Eighteen students were recruited from an *Instructional Systems Design* course at a research university in the Midwest. They did not receive any course credit for their participation, however the discussion activities were scored in the course grade. The discussion grade counted for 20% of the final course grade. A one-factorial quasi-experimental design with three groups was conducted (see Table 1). Participants of this study were assigned randomly to one of the three groups before the class began. Participants could see only their discussion board and were unable to see other groups' activities and comments on them.

Table 1. Design and Sample size

	General Comment	*Interaction Diagram*	*Topic Diagram*
Number of participants	6	6	6
Condition	Being provided with written comments on contents of discussion.	Being provided with interaction diagrams illustrating the numbers of posting and directions of responses.	Being provided with topic diagrams illustrating contents of discussion and flow(agree / disagree) of responses.

Procedure

Students were asked to participate in online discussion as a course task. A total of seven discussion topics were provided to students for seven weeks (one discussion topic per week). From the second week to the fifth week, students received three different types of comments from the instructor according to each of the three experiment groups. Formats of commenting style were developed and practiced before the discussion so that the instructor could provide same types of comment consistently.

On the first day of a discussion task, the instructor posted discussion topics for each ground to initiate the discussion. Students were encouraged to post messages and reply to others. A rubric for scoring discussion was announced to students before the discussion.

When students participated in discussions, the instructor provided three types of feedback on their discussions, aligned with the three groups. Students in the *General Comment* group received comments from the instructor only about the contents of messages they posted. Those in the *Interaction Diagram* group received comments encouraging them to be responsible to others posts, as well as a diagram illustrating the frequency of posting and the relationships of responses. Those in the *Topic Diagram* group received comments monitoring what topic they discussed and how it was elaborated as well as

diagrams illustrating the flow (including agreement and disagreement) of responses. (For the comment types and diagrams refer to Table 2. and Figure 1.)

Table 2. Examples of comments on discussion

Group	Example
General Comment	Your request is quite reasonable. For example, procedural analysis is useful to break tasks into several steps in physical behavior or to examine a content structure in cognitive behavior. Considering EPSS functions, a "Job aid" is supposed to support performance at the moment of need. To develop a job aid, the team has to know which information is needed to conduct a certain performance and what procedure employees follow.
Interaction Comment	Is there anyone who can add your comment? We can add explanation about the definition, finding Ws. In addition, there is a reason listening to various employees.
Topic Comment	David you, developed the issue, sharing common goal well with thoughtful reasons and your personal experience. John! Would you elaborate your thought about analysis tools? How can you gather relevant contents, break the contents into a consistent "chunk", and sort it into the four different functions of the EPSS?

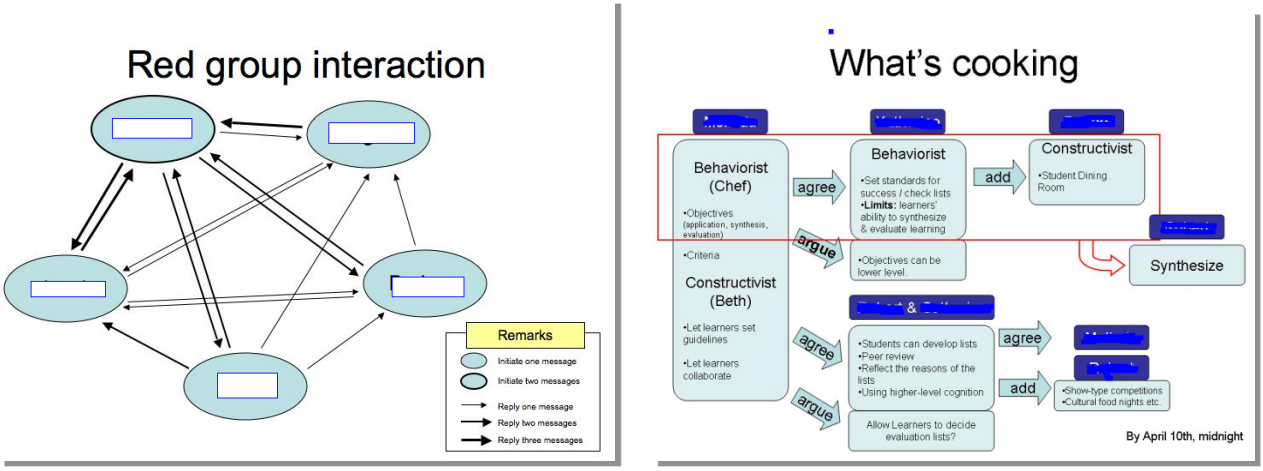

Figure 1. Interaction Diagram (left) and Topic Diagram (right)

Quality of messages

Quality of messages was assessed by an instructor and a TA with a pre-made rubric. There were three categories in evaluating the quality: (1) initiating a new topic; (2) elaborating the topic; and (3) developing conclusion. Each message was coded with one of the categories and scored according to its quality (see Appendix 1). While grading the message, the two raters made negotiated a consensus.

Results

Frequency of posting Messages

The number of messages was measured by counting the posts and responses in each discussion forum. A 3 (groups) X 4 (time) analysis of variance (ANOVA) with repeated measures on time was performed on the number of messages to assess the effect of the comment types and diagrams on discussion interactivities. There was a significant difference in the number of messages in the discussion forums, $F(2, 15) = 6.86$, $p < .01$ (partial eta squared of .48). Analyses using the Bonferroni post hoc criterion for significance indicated that the *Interaction Diagram* group posted more messages (estimated M = 8.0, Std. error = .81) than the Topic Diagram group (estimated M = 3.9, Std. error = .81).

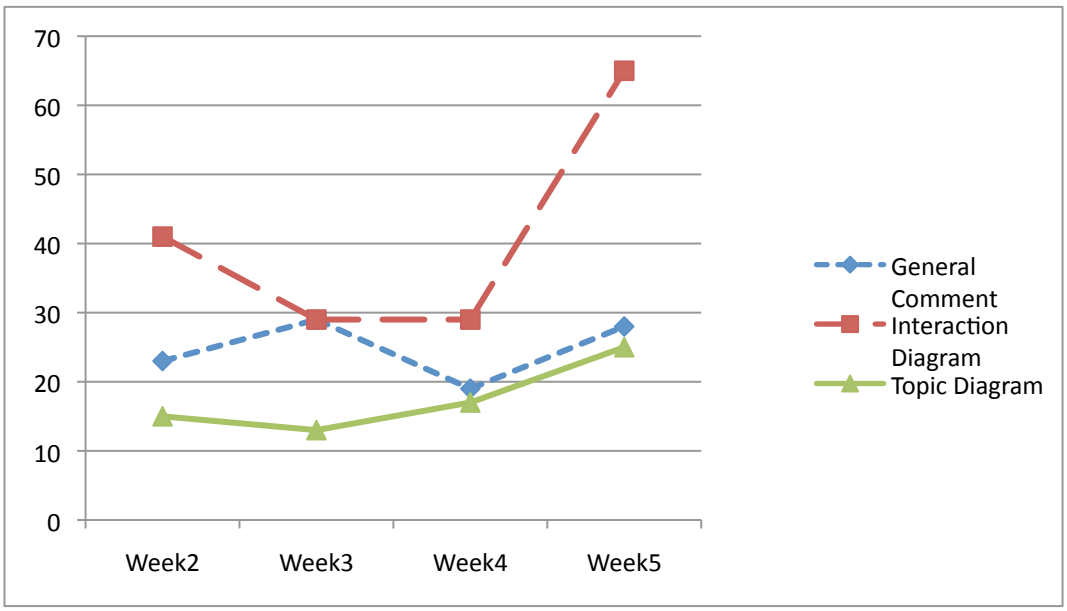

Figure 2. The number of messages on discussion board per week

Quality of Messages

The quality of messages was measured by assessing each message on the basis of course grading rubric (see Appendix 1). Table 3 describes the overall quality of messages per group.

Table 3. Overall quality of messages

	General Comment	*Interaction Diagram*	*Topic Diagram*
Category 1: initiate discussion by posting new idea	M= 4.83 SD=.565 N= 24	M= 4.68 SD= .945 N= 25	M= 5 SD= 0 N= 19
Category 2: elaborate discussion by supporting or opposing ideas	M= 2.82 SD= 1.487 N= 99	M= 2.67 SD= 1.523 N= 164	M= 4.11 SD= 1.43 N= 70
Category 3: reach a conclusion by evaluating or synthesizing ideas	M= 5 SD N= 1	M= 3.67 SD= 1.155 N= 3	M= 4 SD= 1.155 N= 4

To examine how students interacted with each other in constructing meaningful discussion, category 2 and 3 were analyzed. Because of low frequency, the category 3 was excluded in the further analysis. A 3 (groups) X 4 (time) ANOVA with repeated measures

on time was performed and revealed main effects of comments types, $F(2, 321) = 22.977$, $p < .01$ (partial eta squared of .13). Post hoc analyses using the Bonferroni criterion for significance indicated that the *Topic Diagram* group (M=4.11, SD=1.43) outperformed other two groups (General Comment:M=2.82, SD=1.49; Interaction Diagram: M=2.67, SD=1.52) in terms of message scores (see Figure 3).

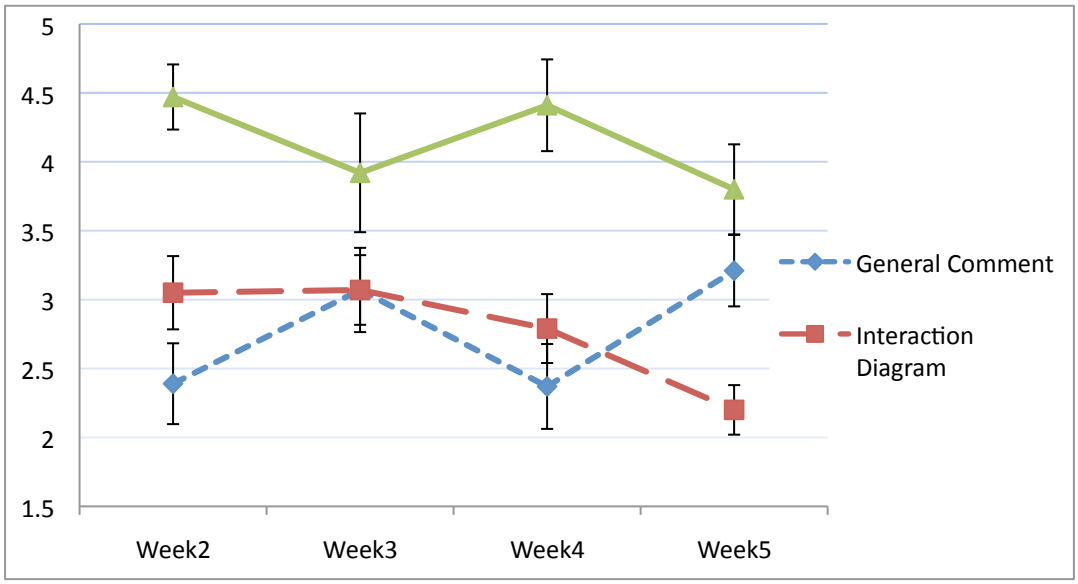

Figure 3. The mean score of messages on discussion board per week

Discussion

This study examined the effects of comment styles on discussion activities. Overall, the interaction diagram and comments on interactivities encouraged students to be active in discussion. As a result they posted more messages and responded to others' post more frequently. However, considering the quality of messages, we cannot assure that high interactivity guarantees knowledge construction. Although reasonable interactivity (measured by the number of postings) is a necessary condition, it cannot be a sufficient condition. Davies and Graff (2005) also revealed that students who interacted and participated more in online discussions did not necessarily achieve higher grades.

In contrast to the results, the topic diagram and comment on discussion flows seemed to suppress interactivity to some degree but encouraged students to elaborate their ideas and be responsive to others' messages. This result replicated Jeong and Joung's (2007) study, which revealed that students were reluctant to add critiques when a title indicated message's contents as opposing or supporting. However, the current study suggested a meaningful implementation which encouraged students to elaborate their arguments with more plausible reasons by illustrating discussion flows.

This study could not answer why the quality of two group were different. Further analysis on discussion contents will reveal the relationship between the interactivity and quality of discussion.

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Appendix 1. Rubric of discussion

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Discussion

Student Name:

Criteria	Possible points	Your points	Comment
Contribute to discussion by initiating a new discussion topic, providing a new idea, or clarifying a discussion goal.	5		
Contribute to discussion by responding peers' message with supporting evidence, counter arguements or alternative aspects.	5		
Contribute to discussion by evaluating or synthesizing topics to reach a conclusion.	5		
Total Point:	15	0	
Course Points: (Your Points/Points Possible)*3		0	

Discussion Rubric

Criteria 1	Contribute to discussion by initiating a new discussion topic, providing a new idea.	
Score	Description	Examples
5	A message clearly relates to the main discussion topic and provides a new concept, information. It includes supporting details and/or evidence.	Teachers in the Spring Wells High School had a performance problem which didn't satisfy the requirement of certification achievement. If they fail to reach the standard requirement, Spring Wells will lose its funding for technology equipment purchases. The critical need of the school is to meet certification level and this can be achieved by providing professional development workshop.
3	A message clearly relates to the main discussion topic and provides a new concept, information. However, It does not include supporting details and/or evidence.	Teachers in the Spring Wells High School had a performance problem. Only 75% of them got the novice and 40% did the practitioner certification last year. Besides, students' scores of state proficiency test are low, as a result, the school was desingated "continuous improvement". Teacher need to have professional development workshop.
1	A message little relates to the main discussion topic and hardly provides a new concept, information.	Suzanne Garner is a technology coordinator for Spring Wells High School. She got a grant from the TPDG, so she have a right to decide where to investiagte. I believe she made a right decision to encourage teachers to adopt new technologies into their classroom.

Criteria 2	Contribute to discussion by responding peers' message with supporting evidence, counter arguements or alternative aspects.	
Score	Description	Examples
5	A message provides a meaningful feedback for a peer' opinion by supporting or criticizing it. The message includes logical and persuasive basis. It may suggest an alternative view point.	Tom, your point is reasonable but I have a different idea. The fundamental purpose of schools is to educate students and the proficiency test scores can be a direct indicator of its achievement. Spring Wells High School has been designated "in emergency" due to its low proficiency test scores. This is most critical problem to be solved immediately. As the Principal stressed, seminars for teachers that focus on assessment and the implementation of curriculum standards will work for this problem.
3	A message provides a meaningful feedback for a peer' opinion by supporting or criticizing it. However, the message does not include logical and persuasive basis.	Tom, your point is reasonable but I have a different idea. Spring Wells High School need to improve students' proficiency test scores. It is very important and many teachers agree with that. The Principal also stressed the importance of seminars for teachers that focus on assessment and the implementation of curriculum standards.
1	A message hardly provides a meaningful feedback for a peer' opinion.	Tom, your point is reasonable but there are something to improve. In my opinion, you need to see in a different perspective. I found other problmes in Spring Wells High School.

Criteria 3	Contribute to discussion by evaluating or synthesizing topics to reach a conclusion.	
Score	Description	Examples
5	A message reveals the understanding of discussion topics and analyzes other peers' opinions. It provides conclusive decision for one topic.	I agree with Catherine's idea. The reason Suzanne has tried to encourage teachers to use technology is that she believe it may promote students' learning outcomes. However, I couldn't find any direct evidence supporting her belief as Tom criticized. Moreover, the Principal, a stakeholder, focuses on proficiency test scores. They need direct guidances to improve their class to meet state proficiency standard.
3	A message reveals the understanding of discussion topics but hardly analyzes other peers' opinions. It provides conclusive decision for one topic.	Finally, I think they need direct guidances to improve their class to meet state proficiency standard. The Principal suppots this idea and students' proficiency test scores need to improve. Although Spring Wells has other problems, it is most important to improve teachers' skill on assessment and implementation of curriculum standards.
1	A message hardly reveals the understanding of discussion topics and does not analyze other peers' opinions.	Every school problems due to motivation of students. Although the Principal and Suzanne consider teachers' competency, most important issue is to modivate students to learn. Nothing will change without changing students.