

Visualization Of Agreement And Discussion Processes During Online Collaborative  
Learning

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### Abstract

This study examined the effects of the *Shared Space* (SS) on students' behaviors in a computer-supported collaborative learning (CSCL) environment. The SS visualizes discussion and agreement about a topic during online discussions. It was hypothesized the SS would increase the media richness of the CSCL environment, would stimulate critical and exploratory group norms, would lead to more positive perceptions of online collaboration, and would have an impact on students' collaborative activities. 59 students working in 20 groups had access to the SS visualization, while 58 students working in 20 groups did not. The results show that students with access to the SS visualization, a) have a more critical group norm perception, b) perceive more positive group behavior, and c) perceive their group's task strategies to be more effective. Students with access to the SS visualization only perceive marginally higher media richness. The SS visualization only had a small impact on student's collaborative activities.

## Visualization Of Agreement And Discussion Processes During Online Collaborative Learning

Computer-supported collaborative learning (CSCL) is seen as a potential tool for education for several reasons. First, research has demonstrated positive effects of using ICT in education (e.g., Fletcher-Flinn & Gravatt, 1995). Second, research has also demonstrated positive effects of using collaborative learning. When students work together in small groups, they perform better and learn more, compared to students working individually (Johnson & Johnson, 1999). Third, several studies demonstrated the combination ICT, telecommunications, and collaborative learning to be effective (Cavanaugh, 2001).

Notwithstanding the positive effects of using CSCL, many studies have also demonstrated possible pitfalls when using CSCL. For example, students working in CMC groups sometimes perceive their discussions as more confusing or participate in unsustained, low quality discussions. In sum, positive and productive social interaction is sometimes lacking during CSCL (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003).

The following sections discuss two problems that may occur during CSCL, namely communication and discussion difficulties due to lower media richness and students' difficulties to conduct critical, yet constructive discussions. Possible explanations for these problems will be described in short. The final section of this introduction will describe how these problems may be addressed in order to facilitate effective CSCL.

### *Communication difficulties during CSCL.*

Research has demonstrated that for group members it is difficult to communicate during CSCL. Traditional CMC systems, such as e-mail or chat, are seen as media that are low in media richness (Daft & Lengel, 1986). Media richness is defined as a medium's ability to facilitate communication and the establishment of shared meaning. Factors such as the ability of the medium to transmit multiple cues (e.g., facial expressions, verbal sound), and the immediacy of feedback, influence its richness. As media richness decreases, group members have more difficulties conveying their opinions and ideas and it is more difficult to determine the meaning of messages. Thus, since CSCL environments are sometimes low in media richness, communication difficulties between group members tend to surface from time to time. However, this may not apply to systems that offer audio or video channels for communication.

*Lack of critical but constructive discussion during CSCL.*

When group members work together, they are usually working on complex problems, which require the input of all group members and which require them to jointly reason about solutions and strategies. Ideally, group members engage in discussions that are critical, but also constructive. This means that group members are critical of their own and their group member's ideas and offer explanations for their opinions and arguments. These types of discussions have been called exploratory discussions by Mercer (1996) and have been found to enhance learning during collaborative activities. However, research has shown that students rarely give arguments during collaboration (Kuhn & Udell, 2003), nor do they offer explanations for their ideas regularly (Van der Meijden & Veenman, 2005).

The relative absence of critical but constructive discussion may be explained in several ways. First, students may not know how to conduct such discussions and may not possess the necessary skills. Second, as stated above, students may find it difficult to engage in critical debate in a CSCL environment and may have difficulties interpreting online discussions (e.g., they may not know whether group members agree or disagree with them). Finally, groups may possess group norms that stimulate consensus among group members, instead of critical or exploratory discussion. Group norms are rules or standards that are accepted by all group members and prescribe behavior. Groups with a critical group norm collaborate more critically and constructively, compared to groups with a consensus group norm. Thus, group norms may impact the way groups engage in online discussions (Postmes, Spears, & Cihangir, 2001).

*Addressing communication and discussion problems using visualizations.*

This section describes a visualization called *Shared Space* (SS). The SS visualizes whether group members are agreeing or disagreeing about a topic during online discussion. This visualization has been implemented in an existing CSCL environment. Next, it is described why and how the SS may address the problems described in the previous sections.

The SS was implemented in the *Virtual Collaborative Research Institute* (VCRI, Jaspers, Broeken, & Erkens, 2005). This is a groupware environment designed to facilitate CSCL (see also the Task and materials section). More specifically, the SS is an extension of the *Chat tool* of the VCRI-program. The SS analyzes all messages typed in the Chat tool. First, the SS discerns discourse topics based on time intervals. When students do not type messages for more than 59 seconds, a new topic begins. Figure 1 shows a screenshot of the Chat tool with SS visualization.

Second, the SS analyzes the content of each chat message in order to determine whether a chat message indicates discussion or agreement. For this purpose, the SS determines the communicative function of the message. This is done using the *Dialogue Act Coding (DAC) filter* (see Erkens, Jaspers, Prangma, & Kanselaar, 2005). This filter uses over 1300 rules based on discourse markers to determine the communicative function of a chat message. Discourse markers are characteristic words or phrases signaling the communicative function of a message. In total, five main categories of communicative functions are distinguished: argumentative, responsive, informative, elicitive, and imperative. Each category consists of several subcategories. For example, the elicitive category consists of verification questions, open questions, set questions, and proposals for action. In total, 29 different dialogue acts are distinguished. Of these, confirmations, acknowledgements, and positive evaluations are considered indications of agreement, while denials, verification questions, negative evaluations, and counterarguments are considered indications of discussion or debate.

Finally, after establishing whether the chat message indicates discussion or agreement, the SS moves the whole topic to the left or to the right in small steps. When the chat message indicates discussion, the SS moves the topic to the left; when it indicates agreement, the SS moves the topic to the right. The movement of the topics corresponds to the “discussion” and “agreement” headings underneath the chat history. The lines above the topics visualize the development of the online discussion. For example, in Figure 1, at the beginning of the topic, the SS indicated agreement (the line moves to the right), whereas later on the SS indicated debate (the line goes to the left).

It may be hypothesized the SS visualization will help group members overcome the communication and discussion problems described above for several reasons. First, the SS visualization may increase the media richness of the CSCL environment. Because the SS visualizes discussion and agreement, it may be easier for students to determine the positions of group members and whether there is shared understanding. Second, the SS visualization may help group members to become more aware about whether they agree or disagree with each other. This awareness may facilitate collaboration. Third, the SS visualization provides students with feedback about the manner in which they are conducting their discussions. It may help group members to become aware of their discussion strategies and their group norms. Finally, the feedback provided by the SS visualization may help students to engage in group processing. This occurs when group members discuss how well their group is functioning and how group processes may be improved. These discussions may help groups

pinpoint and solve collaboration problems and may reinforce successful collaborative behavior. During these discussions, group members may be stimulated to adopt more critical or exploratory group norms (if necessary). In conclusion, it is expected that SS visualization may alleviate some of the communication problems that occur during CSCL, and may help group members to collaborate and discuss more productively.

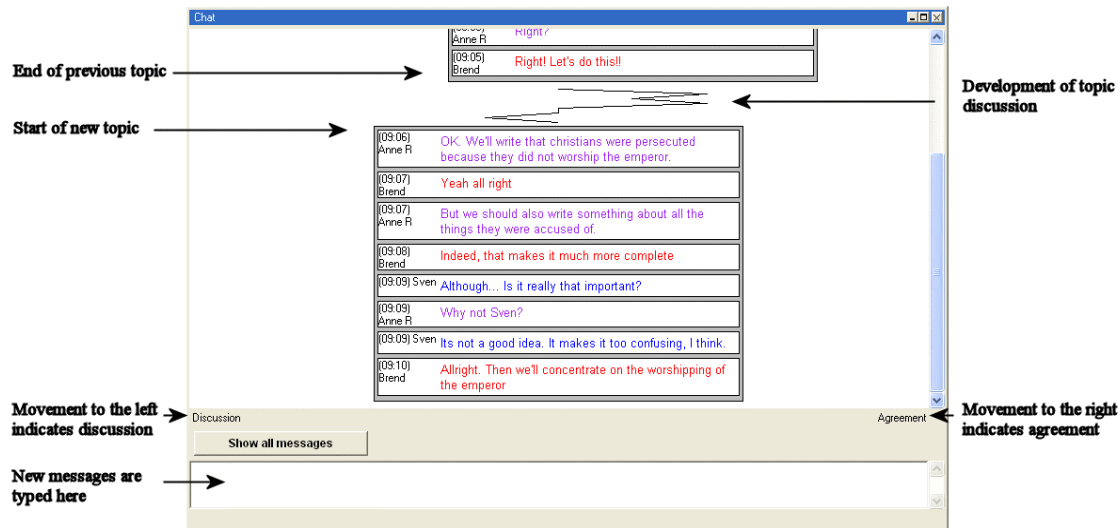


Figure 1 Screenshot of the Chat tool with Shared Space visualization.

### Research Questions

This paper investigates the effects of the SS visualization on online collaboration. This paper addresses four research questions. Do students with access to SS visualization, compared to students without SS visualization: (1) perceive higher media richness when using the Chat tool, (2) perceive different, more critical group norms, (3) perceive their online collaboration and communication differently, and (4) engage in different collaborative activities?

### Method and Instrumentation

#### Design.

A posttest-only design with a treatment and a control group was used to answer the research questions. Treatment group students had access to a chat tool with SS visualization, whereas control group students did not. Students were divided into groups of two, three, or four. Each group was randomly assigned to either the treatment or the control group. The treatment group consisted of 59 students collaborating in 20 groups. Similarly, the control group also consisted of 58 students working together in 20 groups.

### *Participants.*

Participants came from five different history classes from two secondary schools in The Netherlands. All students were enrolled in the second stage of the pre-university education track. Students were randomly assigned to a group by the researchers.

### *Task and materials.*

CSCL environment: Group members collaborated in a CSCL environment called *VCRI*. This is a groupware program designed to support collaborative learning on research projects and inquiry group tasks. Every group member works at one computer. When working with the *VCRI*-program, students have several tools at their disposal. For example, group members use the *Chat* tool to communicate synchronously with group members. To read the description of their group task or to search and read relevant information, students can use the *Sources* tool. This tool lists a number of sources, which can be opened and read. Group members use the *Co-Writer* as a shared word processor. Using the *Co-Writer* group members can texts together simultaneously.

For teachers, an alternative version of the *VCRI*-program is available. Using this *Coach*-program, teachers can monitor the chat discussions of their students, as well as the texts students are producing. Teachers can also send messages to answer students' questions, give tips or hints, or to warn students in case of misbehavior. Finally, the *Coach*-program provides teachers with descriptive information about the participation rates of their students.

Inquiry group task: Participating students worked together on a historical inquiry group task, developed together with the teachers involved in the study. Subject of the task was "The first four centuries of Christianity". The introduction of the task stressed the importance of working together as a group to successfully complete the inquiry task. Students were told they had eight lessons to hand in their reports, and they would receive a group grade for their reports. The inquiry group task can be characterized as an open-ended task; meaning the task does not have a standard procedure and no single right answer. Furthermore, the inquiry task was quite complex and extensive; therefore, no single group member was likely to solve the task on his or her own.

### *Procedure.*

Group members collaborated on the inquiry group task for a period of about four weeks. In total, eight classroom hours were devoted to the inquiry group task. During these hours students worked together on the task, with each student working on a separate computer. Students were seated as far from their group members as possible, in order to

stimulate them to use to the VCRI-program to communicate with group members. After eight lessons, the groups handed in their final versions of the task.

After the last lesson, a questionnaire was administered to the students. This questionnaire contained several items pertaining to perceived media richness, group norm perception, and perception of online collaboration and communication. Students expressed their opinions using a 5-point scale ranging from 1 (=completely disagree) to 5 (=completely agree). Due to absence or sickness, 20 students did not complete the posttest questionnaire.

#### *Measures.*

Perceived media richness of the Chat tool: To measure perceived media richness of the Chat tool, the questionnaire completed by the students during the posttest contained a 15-item scale. The items addressed whether students found discussion and communication through the Chat tool enjoyable, whether they were aware of agreements and disagreements during online discussions, and whether they could explain things easily to group members. Higher scores for this scale (internal consistency  $\alpha = .92$ ) indicate a higher perceived media richness of the Chat tool for collaboration and discussion.

Group norm perception: To measure students' perceptions of group norms, the questionnaire completed by the students during the posttest contained three scales. The first scale consisted of three items, and asked students whether they perceived their group as a critical one. Higher scores on this scale ( $\alpha = .84$ ) indicate a more *critical group norm perception*. The second scale investigated whether students perceived their group as having consensual group norms. A high score on this scale ( $\alpha = .59$ ) corresponds to a more *consensual group norm perception*. Finally, the third scale examined whether group members perceived their group as having exploratory group norms. This scale consisted of seven items, modeled after the ground rules for exploratory talk (e.g., Wegerif, Mercer, & Dawes, 1999). Students with a high score on this scale ( $\alpha = .79$ ) perceive a more *exploratory group norm*.

Perception of online collaboration and communication: To investigate how students perceived their online collaboration and communication the questionnaire contained three scales. The first scale consisted of seven items and addressed *positive group behavior*, such as equal participation of group members. Higher scores on this scale ( $\alpha = .82$ ) indicate more occurrences of positive group behavior. Five items formed the second scale. These items addressed occurrences of *negative group behavior* such as conflicts. Higher scores on this scale ( $\alpha = .68$ ) indicate more occurrences of negative behavior. The final scale addressed students' *perceived effectiveness of their group's task strategies* (Saavedra, Earley, & Van



Dyne, 1993). This scale consisted of eight items that assessed the choices made, and the strategies chosen by group members. Students with a high score on this scale ( $\alpha = .81$ ), perceived their group's task strategies to be effective.

Collaborative activities: To answer the fourth research question, regarding the influence of the SS visualization on students' collaborative activities, a coding scheme was developed. These types of activities are reflected by the four different dimensions of the coding scheme. Each dimension contains two or more coding categories. In total, the scheme consists of 19 categories.

The first dimension referred to *performance of task-related activities*. These activities pertain to chat messages aimed at solving the problem at hand, such as verbalizing ideas and asking questions. This dimension contained two categories pertaining to the discussion of relevant task-related information: *exchanging task-related information* and *asking task-related questions*. The second dimension referred to *regulation and coordination of task-related activities*, encompassing four categories. Metacognitive activities that regulate task performance, such as monitoring task progress, are important for successful group performance (Van der Meijden & Veenman, 2005). First, *planning* involved discussion of strategies necessary to complete the task and choosing appropriate strategies. Second, *monitoring* involved exchange of information that could be used to monitor task performance and progress. Finally, *evaluation* involved appraisal and discussion of task performance, which could be *positive* or *negative*. *Performance of social activities* was the third dimension of the coding scheme. Group members have to attend to the social and emotional element of collaboration to successfully complete a group task. This dimension contained five categories. First, *greetings* were included, since they contribute positively to group atmosphere. Second, *social support* remarks referred to comments that contributed positively to group atmosphere, such as exchanging positive comments. Third, *social resistance* remarks referred to behaviors that contributed negatively to group atmosphere, such as insults. Fourth, *shared understanding* referred to confirmations and indications of agreement, which serve to reach and maintain joint understanding. Similarly, *loss of shared understanding* referred to disagreements, and expressions of incomprehension. The fourth dimension referred to *regulation and coordination of social activities*. Group members need to discuss collaboration strategies, monitor their collaboration process, and evaluate and reflect on their collaboration. This dimension contained four categories. First, *planning* involved discussion of collaboration strategies, such as helping each other, or proposals to work together on certain tasks. Second, *monitoring* referred to the exchange of information

that could be used to monitor group processes. Finally, *evaluation* involved discussion of group processes, which could be *positive* or *negative*. Statements that addressed neutral, negative, or positive *technical* aspects of the CSCL environment were also included in the coding scheme. Finally, statements that did not fit into any of the previously mentioned categories were coded as *Other*. These codes mostly referred to nonsense and off-task remarks. In order to examine interrater agreement, two raters coded 796 collaborative activities independently. An overall Cohen's Kappa of .94 was found (range: .78 - 1.00).

## *Results*

### *Perceived media richness of the Chat tool.*

On average, treatment group students perceive higher media richness ( $M = 3.26$ ,  $SD = .80$ ) compared to control group students ( $M = 3.01$ ,  $SD = .76$ ). However, multilevel analyses indicate that this difference only approaches statistical significance,  $t(95) = 1.59$ ,  $p = .06$ .

### *Group norm perception.*

Regarding critical group norm perception and consensual group norm perception, no statistically significant differences between treatment ( $M = 3.24$ ,  $SD = .86$ ) and control group ( $M = 3.25$ ,  $SD = .65$ ) students were found,  $t(95) = .00$ ,  $p = 1.00$ . Similarly, no differences were found between treatment ( $M = 3.50$ ,  $SD = .89$ ) and control group ( $M = 3.46$ ,  $SD = .66$ ) students regarding consensual group norm perception,  $t(95) = .35$ ,  $p = .36$ . However, treatment group students ( $M = 3.82$ ,  $SD = .53$ ) obtained higher scores for the exploratory group norm perception scale than did control group ( $M = 3.60$ ,  $SD = .53$ ) students,  $t(95) = 2.03$ ,  $p = .02$ . This indicates that treatment group students perceived their groups were engaged more in critical but constructive online discussion, compared to control group students.

### *Perception of online collaboration and communication.*

Treatment group students ( $M = 3.93$ ,  $SD = .54$ ) reported more occurrences of positive group behavior than control group ( $M = 3.62$ ,  $SD = .58$ ) students,  $t(95) = 2.31$ ,  $p = .01$ . Furthermore, treatment group students ( $M = 3.73$ ,  $SD = .56$ ) perceived their group's task strategies to be more effective than control group students ( $M = 3.42$ ,  $SD = .62$ ),  $t(95) = 2.53$ ,  $p = .01$ . However, treatment and control group students ( $M = 2.34$ ,  $SD = .72$ ) reported similar levels of negative group behavior compared to control group students ( $M = 2.54$ ,  $SD = .68$ ),  $t(95) = -1.25$ ,  $p = .11$ .

### *Collaborative activities*

Students were mostly busy planning task-related activities (27.09%) and indicating and maintaining mutual understanding (25.28%). Using multilevel analyses, the effect of the SS visualization on the collaborative activities performed by the students were examined. Only a few significant effects were found. Treatment group students ( $M = 8.17$ ,  $SD = 6.99$ ) formulated significantly less task-related questions than control group students ( $M = 12.33$ ,  $SD = 10.42$ ),  $t(114) = -2.69$ ,  $p = .00$ . Furthermore, treatment group students ( $M = 54.15$ ,  $SD = 31.74$ ) devoted less effort to maintaining and indicating shared understanding than control group students ( $M = 65.25$ ,  $SD = 41.59$ ),  $t(114) = -1.89$ ,  $p = .03$ , although the corresponding  $\chi^2$  was only marginally significant. Finally, treatment group students ( $M = 2.14$ ,  $SD = 2.65$ ) made less negative remarks about the CSCL environment than control group students ( $M = 4.24$ ,  $SD = 4.50$ ),  $t(114) = -1.89$ ,  $p = .03$ . Again, the corresponding  $\chi^2$  was only marginally significant.

### *Conclusions and Discussion*

This study examined the effects of the Shared Space (SS) on students' behaviors in a CSCL environment. The SS visualizes whether group members are agreeing or disagreeing about a topic during online discussion. The results show that students with access to the SS visualization tend to perceive the CSCL environment as more media rich, although this effect only approached significance. Second, the results show an effect of the SS on group norms. Students with access to the SS visualization report more exploratory group norms. Third, students with access to the SS visualization reported more positive group behavior and perceived their group's task strategies as more effective. The SS visualization only had a small effect on students' collaborative activities. Students with access to the SS visualization asked less task-related questions, were less busy maintaining and indicating shared understanding, and made less negative remarks about the CSCL environment.

In all, these results show that the SS had a positive effect. First, the SS seemed to facilitate communication and discussion. Students perceived the medium as marginally more media rich. Furthermore, students needed to devote less effort to maintaining and signalling shared understanding. Second, the SS stimulated a more critical, exploratory group norm perception. Treatment group students perceived their group as more engaged in a constructive but critical online discussion. Finally, the SS influenced students to their group's behavior as more positive and their group's task strategies as more effective.

Several limitations of this study should be kept in mind. First, the effect of the SS on group performance and individual achievement are not clear. Therefore, future analyses will focus on the quality of the group products written by the groups. Second, it is not clear how students perceived and interpreted the SS visualization. Did students interpret the visualization correctly? This may have had an impact on the effect of the visualization. This will be analyzed further by examining the chat discussions.

Overall, the results of this study were positive. Whether these results can be replicated with other students, other types of groups or using different types of tasks, remains to be seen. In our own future research, we will explore the merits of visualization during collaboration further.

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