Title	Integrating CMC and verbal discussions in students' collaborative learning in a F2F classroom
Authors	Chen Wenli, Looi Chee-Kit and Tan Sini
Source	*8th International Conference on Computer Supported Collaborative Learning (CSCL), Rhodes, Greece, 8 - 13 June 2009*
Published by	International Society of the Learning Sciences

Citation: Chen, W., Looi, C.-K. & Tan, S. (2009). Integrating CMC and verbal discussions in students' collaborative learning in a F2F classroom. In A. Dimitracopoulou, C. O'Malley, D. Suthers, P. Reimann (Eds.), *Proceedings of the 8h International Computer Supported Collaborative Learning (CSCL) 2009* (Part1, pp. 315-319). Rhodes, Greece: International Society of the Learning Sciences.

Integrating CMC and Verbal Discussions in Students' Collaborative Learning in a F2F Classroom

Wenli Chen, Chee-Kit Looi, Sini Tan
Learning Sciences Lab, National Institute of Education, 1 Nanyang Walk, Singapore 637616
wenli.chen@nie.edu.sg, cheekit.looi@nie.edu.sg, sini.tan@nie.edu.sg

Abstract: This paper analyses the role of different communication modes in students' collaborative learning in a Primary Grade 5 blended learning environment in Singapore. Small groups of students interacted face-to-face over a CMC technology called Group Scribbles (GS) to jointly complete a learning task. We analyzed the construction and evolution of the interactions through analyzing the artifacts that are produced by a group of students - in the verbal talk, gestures, and sketches drawn and text inscribed in GS. F2F and GS interactions intertwined to support collaborative learning. The findings from this study could inform the design of integrating and reinforcing the strengths of both communication modes when introducing CSCL in a F2F classroom.

Introduction

Computer technologies play an important role in supporting students' collaborative learning. In a computer-supported collaborative learning (CSCL) environment, participants are actively and collaboratively engaged in creating knowledge, and the collaboration is taking place through a computer network. They engage in a coordinated effort to perform a task together to establish common knowledge (Littleton & Hakkinen, 1999).Various projects have examined the effectiveness of technologies that support collaboration among learners. While much CSCL research was conducted in pure computer-based settings where there is no face-to-face (F2F) interaction among learners (e.g., in a distance learning context), this paper investigates the role of networked technology in a face-to-face classroom to determine the effects of different communication modes in order to harness the synergy of both communication modes in students' collaborative learning.

There are three actors in this F2F CSCL environment: the teacher as the facilitator, the student as the task performer/problem solver, and the different communication modes as the mediator of the collaboration process. Introducing different modes of communication in the classroom provides different kinds of scaffolding and support for enabling the cognitive and social interactions between the participants involved. In this paper we examine how CMC and face-to-face interaction intertwine to support students' collaborative learning.

CMC Technology Used in Classroom - GroupScribbles

The CSCL technology used in classroom is GroupScribbles (GS) 2.0. GS user interface presents each user with a two-paned window (see Figure 1). The lower pane is the user's personal work area, or "private board", with a virtual pad of fresh "scribble sheets" on which the user can draw or type. A scribble can be shared by being dragged and dropped on the public board in the upper pane which is synchronized across all devices. It enhances the characteristics of sticky paper notes and student response system (SRS) by providing their key features while avoiding some of their physical constraints (DiGiano, Tatar, & Kireyev, 2006). It enables collaborative generation, collection and aggregation of ideas through a shared space.

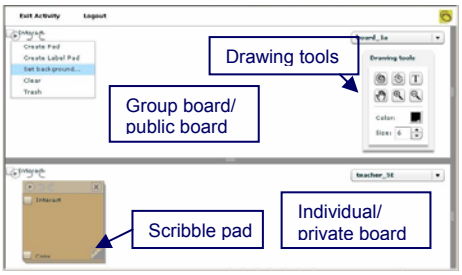


Figure 1. GS User Interface

The essential feature of the GS is the combination of the private board where students can work individually and group boards or public boards where students can post the work and position it relative to others, view others' work, and take items back to the private board for further elaboration. GS is a general-purpose collaboration tool in the sense that we do not have to need to have a pre-defined topic or task.

Context, Participants & Lesson Design

In our work with a primary school in Singapore, students from two primary 5 classes (one high ability class and one mixed ability class, each class has 40 students) have used of GS technology for a period of 1.5 years. Each week they had one or two sessions (1 hour per session) of GS-based lessons in the computer laboratory. Each student was equipped with a Tablet-PC with GS software installed. The GS was implemented in systematic learning situations where students used it to learn Science, Mathematics and Chinese language. These activities were co-designed by the researchers and the teachers and were integrated tightly with the school syllabus.

In our design, in a 1-hour GS based lesson, about half of the time was devoted to let students use GS to do collaborative learning task with the facilitation of the teacher. When doing a group task, students worked in groups of four. A typical collaborative pattern when student group is jointly doing a task is as follows: Individual group member works on the private space in the Tablet PC respectively, then posted to a group board which is synchronized to all group members. They build on each other's ideas and create the group artifact. After finishing the group task, they visit other groups' board, learn others' ideas and give comments and suggestions. Then they go back to the home group board to check the comments given by others and further refine the ideas. At the end the groups that have the best performance present their work to the whole class.

Frameworks for Interactional Analysis of Collaboration

We take the perspective of interaction analysis as the analytical tool of this study. Interaction analysis is an interdisciplinary method for the empirical investigation of human relations with each other and environment (Jordan & Henderson, 1995). In analysing interactions in CSCL environments, researchers have to take into account the construction and manipulation of representations on the shared workspace which may or may not be augmented by face-to-face interactions. Participants collaboratively build knowledge through negotiation and sharing of their perspectives on constructed/co-constructed representations, bringing upon a flow of interrelated ideas that provides the basis for the group's intersubjective meaning-making (Suthers, 2006), common ground (Clark & Brennan, 1991) and a shared world (Stahl, 2008). The works of Dillenbourg (1999) and Stahl, Koschmann & Suthers (2006) call for the need to design process-oriented methodologies to analyse interactions.

Much work in interaction analysis focuses on interactions in a text-based online environment. It is a real challenge for us to adopt an existing analytical protocol to analyze students' interactions in a media-rich collaborative environment when multiple communication modes are available. Therefore in this paper, we will analyze both face-to-face discourse as well as media representations on the CSCL environment. We will describe all the student-student and student-interface interactions in this media-rich environment by presenting the discourse, behaviour, and media representations of members of a group. Multiple point logs to analyze the interactional scripts to capture the overall picture of the collaboration process will be used. Our analysis will foreground the role of communication modes in serving different purposes when jointly doing the task.

Case Study Method & Data Collection

A descriptive case study has been carried out and one typical GS-based activity was randomly chosen. This covers a primary 5 science topic about the correct configuration of connecting a light bulb with batteries in a circuit. The students are to deduce how to connect the circuit components together in order to make the bulb light up, using on their prior knowledge of a closed circuit. This activity was carried out as a group work. The group members were seated together, facing one another. The group (the target group) we chose to examine comprised of two high ability students (Joel and Bruno), one medium ability student (Serena) and a low ability student (Agnes). Only the role of a group leader was pre-assigned. For this group, Agnes was the group leader.

The activity started by getting the students to individually sketch out their initial impressions of how to connect closed circuits with a light bulb in their GS private board. They contributed their scribble sheets to their own GS group board and then discussed as a group. This task of consolidating the ideas on the same platform will help them to infer the key similarities in constructing a working closed circuit, from the various contributions posted in their group board. The students were be also provided with some electrical components (batteries, light bulb and wires) to physically connect the circuits following the manner they had sketched earlier in GS and to test them if they would work. Later, they had opportunities to look at other GS boards to be exposed to the different ideas contributed by the other groups. They could also comment on other GS posts if they desired to do so. This would reinforce their newly learnt concept of a closed circuit with a light bulb.

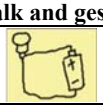
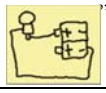
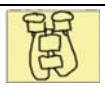
Qualitative data were obtained including both verbal and GS-mediated interactions among students. As for the analysis of the target group's interactions, researchers watched the video captured by Morae for each member of the group, and transcribed the actions and interactions within the group. In the analysis, we chose to focus on the participants' interactions regarding substantial questions/problems related to the study case. The actions included how students worked individually and collaborated on the tasks through creating or editing artifacts on GS, verbal conversation and their physical gestures.

Data Analysis & Findings

The transcripts (see Table 1) we have chosen are typical instances of the target group's interaction in the same activity. The letter in each label is used to represent the participant who had carried out the action (e.g. "B" for Bruno) in that particular segment. Each segment of interaction will be represented by a unique numerical index from the respective label. The increasing order and the sequential order of these numerical indexes represents its chronological order and its continuous flow of these segments respectively. There are omitted segments which we deem irrelevant for data analysis. The group activity transcribed here shows how the group arrived at a collection of electrical circuits' sketches on their group board as instructed by the teacher.

Table 1. Transcript of students' interaction (F2F and CMC) when working on a circuit activity together

(Researcher's interpretations, based on observations of the recorded videos, are shown within parentheses)

Label	Time	Participant	Mode	Verbal talk and gesture via F2F / Artifact & communication via GS
B1	12:57	Bruno	GS	Created "  " on private board.
B4		Bruno	F2F	(To Agnes) "Done! Agnes!" *(Tried to swivel his LCD to show Agnes)*
J5		Joel	F2F	*(Turned his head and looked at Bruno's work)*
B6		Bruno	F2F	(To Joel) "Will this do?" *(Swiveled his LCD back to show Joel)*
J7		Joel	F2F	(To Bruno) "Will, it will."
B8		Bruno	F2F	(To Agnes) "Agnes! Is this ok?" *(Swiveled his LCD back to show Agnes)*
S9		Serena	F2F	*(Looked at Bruno's screen)*
A10		Agnes	F2F	(To Bruno) "Ok." *(Stood up and looked at his LCD)*
19	12:58	All	F2F	*(The group proceeded to set up the circuit for experimentation)*
B21	13:00	Bruno	F2F	(To Joel) "No, it must be connected at the same place." *(Connected the components to construct the circuit with Joel)*
J22		Joel	F2F	(To Bruno) "See I told you! It's here!" *(Connected the wires – one wire to the metal casing, one wire to the metal tip)*
B23		Bruno	F2F	(To Joel) "Just put them at the bottom." *(Connected both wires to the metal tip)*
B24	13:01	Bruno	GS	Realized his initial plan is incorrect and undid the last few strokes of the post (from B1) to "remove" the wire on the left side and re-draw the wire connecting to the casing. He left the finalized post "  " on his private board.
T42	13:04	Teacher	F2F	(To the group) "You never draw! Draw your two batteries!"
B43	13:05	Bruno	GS	Started to draw his circuit on his private board.
T44		Teacher	F2F	(To the group) "One member draw, the other three fix the circuit."
45	13:06	All	F2F	*(The rest continued with the hands-on experimentation, then managed to construct one successful series circuit)*
			GS	Bruno finished "  " on private board. Then he posted it together with "  " onto the group board.
46		All	F2F	*(Bruno joined Joel and Serena in continuing the hands-on experimentation)*
			GS	Agnes then proceeded to sketch the series circuit out on Bruno's tablet PC, but only finished halfway at "  ".
S61	13:08	Serena	GS	Went to another group (group 2) board and saw the circuit "  " drawn on the board.
S62		Serena	F2F	(To the rest) "We all try this one. We all try this one." *(Stood up, swiveled and pointed her LCD to show Bruno)*
B63		Bruno	F2F	(To Serena) "I wanna try this one." (Agreed with Serena)
J64		Joel	F2F	(To Bruno) "Look at the board." *(Pointed the circuit on Serena's LCD which Serena was referring to)*
A65		Agnes	F2F	*(Stood up and turned her head to look at Serena's LCD)*
66	13:09	All	F2F	(The group started constructing the circuit according to what was shown in S61)
67		All	F2F	*(The rest continued with the hands-on experimentation)*
			GS	Agnes sketched on her LCD once the group had tested the circuit worked.
70	13:10	All	F2F	*(Joel initiated to build on the existing circuit and to explore with two light bulbs, then Bruno and Serena helped Joel to connect accordingly to what he wanted)*
			GS	Agnes used Bruno's tablet PC instead and started sketching.
A77	13:11	Agnes	GS	Continued sketching and posted "  " on the group board.
A78	13:12	Agnes	GS	Moved back to her seat, sketched "  ", which was according to what the rest had experimented. Then she posted onto the group board.

Task Distribution and Coordination

Task distribution includes role distribution and awareness of one's responsibility. The task was distributed – each member negotiated and chose a task. In our observation, we found that the task distribution was done via both F2F and GS. Some students explicitly talked to other group members concerning the part he/she would be working on. Another student might work on GS directly and shared his work by shifting the scribble sheet to the group/public board to indicate his/her role without an explicit verbal indication.

In T42 – 46, when all group members were doing the hands-on task, Bruno broke off from the group and took on the role of sketching the circuit, while the group continued in their hands-on experimentation. Subsequently, Agnes switched to voluntarily sketch that series circuit. In this case, task coordination was done not by verbal talk but by Agnes's behavior and the GS artifacts - Agnes noticed that Bruno was going to join the group in the hands-on activity; she had to leave the group activity for a while with the intention to sketch that series circuit. She saw the absence of the series circuit sketch and continued her task to sketch that out.

Within-Group Negotiation

Before converging towards the final solutions of all the workable circuits, the group members went through a lot of negotiations by both verbal talk and GS communication.

To understand the students' cognitive understanding of the concept, we administered a pre-test for all the students and found that three of the members (Serena, Agnes and Joel) had the prior knowledge of connecting the wires to the metal tip and metal casing of the light bulb. Bruno, though he was known to be the top student, gave a wrong answer. Serena, Agnes and Joel overlooked his circuit sketch (B1–A10) when Bruno asked them to check his answer. However, in B21–B24, when Joel and Bruno tested out their circuits they had sketched, they realized that they had conflicting views of constructing the circuit. After Joel showed Bruno his own way of connecting the bulb is correct, Bruno asked Joel to experiment using his (Bruno's) way and then he realized it failed to light the bulb. Subsequently, Bruno amended his sketch on his post to the correct one.

Many verbal negotiations were based on the GS artifacts in the group board. By sharing their work in the group board, they made their individual thinking visible to other group members. When the group members saw one another's postings, they asked one another questions, elaborated their ideas, and clarified their stands. They also refined postings according to others' comments. After the meaning-making and negotiation process, they refined the postings and finally reached shared understanding and knowledge. The end product of the group was shown in their group board GS by consolidating all group members' ideas.

Cross-Group Meaning-Making

After the group work, the students did a "gallery walk" to browse other groups' postings by clicking other group boards. This helped students to be exposed to more different ideas and different perspectives. In addition, they were required to give comments and suggestions to other groups. Then they went back to their own board to improve their own group work based on others' comments and suggestions. The interactions across different groups during "virtual gallery walk" were through GS solely as students could not verbally talk to other groups who were not seated next to them. However, the group members did discuss verbally within the group when they were browsing other group boards.

For example, when Serena browsed the other groups' boards, she was attracted by a circuit on one group board and she expressed her interest to her group members to try out that particular circuit connection she saw. The rest were interested in her suggestion and tried to test the circuit (S61–67). When the group saw that the circuit worked, Agnes drew a duplicate and posted it onto their own group board (67, A77 & A78). After the group took up this new idea, Joel continued to probe this circuit further during the hands-on experimentation (70). With the help of his group mates, he managed to develop a more complicated circuit based on the previous one by adding one more bulb and making both bulbs light up and Agnes sketched it out (A78).

Discussion and Conclusion

In the GS-based learning activity described in this study, the students built collaborative knowledge, created shared meaning, clarified the group's terminology, and created significant artifacts. We observe the construction and evolution of the knowledge in the artifacts that are produced in the group—in the sentences spoken, sketches drawn and texts inscribed. This F2F CSCL design recognizes two networks: the social network, where group members interact verbally, and the technological network that transparently supports the social network activities, by coordinating and synchronizing activity states and mediating the activities and the social interaction of the participants (Zurita & Nussbaum, 2004).

The organization of the classroom into small groups established by this model fosters the verbalization of ideas (Artzt & Armour-Thomas, 1992). With the configured seating arrangement, the students leverage on F2F discussions for immediate communication such as clarifying, referencing other work, etc. to improve on their own ideas. We observe that students often elaborated their GS ideas to each other via verbal talk. They also verbally negotiated amongst themselves before sharing their GS artifacts to the rest of the class. This study supports the findings of research on the role of verbal talk in collaborative learning - verbal language is a fundamental tool through which learners elaborate thoughts, explain results, evaluate solutions through appropriate feedback, explore and clarify inconsistencies and knowledge gaps, link the verbal information to new strategies and tangible actions, and so benefit from the cognitive restructuring that underpins cognitive change (Fawcett & Garton, 2005; Teasley, 1995).

The intertwining of online and F2F modalities play an important role in unifying and strengthening the student collaborative learning experience described in this paper. GS and F2F interactions are complementary to

each other rather than supplementary to each other. Media Richness Theory (Daft & Lengel, 1986) states that the degree of richness of a communication medium is dependent on the capacity of the medium to process ambiguous communication, and suggests that richer media are more effective for equivocal tasks, and leaner media are better for unequivocal tasks. According to the theory, F2F communication is considered to be the richest, while GS is thought to be leaner since they have fewer contextual cues compared to face-to-face (Daft & Lengel, 1986). Effective collaborative learning often involves both equivocal and unequivocal tasks. Thus it would be ideal if we can combine both types of interactions to support deep and meaningful collaborative learning in real classroom settings. While F2F interactions enhance small group meaning-negotiation, GS enhances classroom communication across different groups. GS provides displays that reveal what students are doing, thinking and understanding. Student's contributions are stored for future reference, providing the affordances for the whole class to construct knowledge together. Teachers can use the information provided through GS to augment the natural communication flow of the whole classroom. Both media enhance the development and quality of the content of the discussion and the collaborative process by encouraging the exchange of ideas and by fostering participants' interdependence.

The findings from this study can inform the design of a blended learning environment. The issue of how to balance the F2F and CMC components is still a challenge for blending learning environment design. A variety of preconditions, such as the socio-cultural context, the curriculum, the course, students, teachers, and resources, will have an effect on the balance of the communication medium. Further analysis is needed to probe the relationship between GS and F2F in other scenarios (e.g., different subject or topic areas, different types of task, different group formations).

References

Artzt, A. F., & Armour-Thomas, E. (1992). Development of a cognitive–metacognitive framework for protocol analysis of mathematical problem solving in small groups. *Cognition and Instruction, 9*(2), 137–175.

Clark, H., & Brennan, S. (1991). Grounding in communication. In L.Resnick, J. Levine & S. Teasley (Eds.), *Perspectives on socially-shared cognition* (pp. 127-149). Washington, DC: American Psychological Association.

Daft, R.L. & Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science 32*(5), 554-571.

DiGiano, C., Tatar, D., & Kireyev, K. (2006). *Learning from the Post-It: Building collective intelligence through lightweight, flexible technology.* In Conference on Computer Supported Cooperative Work Companion, Banff. Retrieved Oct 16, 2008, from http://Group Scribbles.sri.com/publications/index.html

Dillenbourg P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed), *Collaborative-learning: Cognitive and Computational Approaches* (pp.1-19). Oxford: Elsevier.

Fawcett, L. M., & Garton, A. F. (2005). The effect of peer collaboration on children's problem-solving ability. *British Journal of Educational Psychology*, 75, 157–169.

Jordan, B., & Henderson, A. (1995). Interaction analysis: foundations and practice. *Journal of the Learning Sciences, 4*(1), 39-103.

Littleton, K. & Hakkinen, P. (1999). Learning together: Understanding the processes of computer-based collaborative learning. In P.Dillenbourg (Ed.) *Collaborative Learning: Cognitive and Computational Approaches*. Oxford: Pergamon.

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning. In K. Sawyer (Eds.), *Cambridge handbook of the learning sciences* (pp. 409 - 426). New York: Cambridge University Press.

Stahl, G. (2008). *Integrating synchronous and asynchronous support for group cognition in online collaborative learning.* Paper presented at the International Conference of Learning Sciences (ICLS '08), Utrecht, Netherlands.

Stahl, G. (Ed.). (2009). *Studying virtual math teams*. New York, NY: Springer.

Suthers, D. D. (2006). Technology affordances for intersubjective meaning-making: A research agenda for CSCL. *International Journal of Computer Supported Collaborative Learning, 1*(3).

Teasley, S. (1995). The role of talk in children's peer collaboration. *Developmental Psychology, 3*(2), 207–220.

Zurita, G., & Nussbaum, M. (2004). Computer supported collaborative learning using wirelessly interconnected handheld computers. *Computers & Education*, 42(3), 289–314.

Acknowledgments

This material is based on the work supported by the National Science Foundation (United States) under Grants 0427783 and 0713711 and by the National Research Foundation (Singapore) under Grant NRF2007-IDM003-MOE-001. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the National Research Foundation. We are grateful to Mayflower Primary School for collaborating with us on this research.