Towards Analysis of Group Interaction Processes Mediated by a Rapid Collaborative Learning Environment

Chee-Kit Looi, Wenli Chen, Sini Tan, Yun Wen, Juan Dee Wee
National Institute of Education, 1 Nanyang Walk Singapore 637616
cheekit.looi@nie.edu.sg

Abstract: We have been involved in a 3-year project to introduce rapid collaborative knowledge building practices in two primary 5 classrooms. Lessons in science, mathematics and the Chinese language have been co-designed by teachers and researchers to teach the curriculum by tapping on collaborative work in small groups as well as in the whole class. They incorporate various activities supported by the Group Scribbles (GS) software technology. GS provides representational spaces for individual, group or class work to support collaborative practices. In this paper, we share one process-oriented account of a small group interaction through face-to-face communication over the GS environment. We adapted Suthers, Dwyer, Medina & Vatrapu's uptake analysis framework (2007) to study group interaction and meaning-making mediated by GS as well as verbal talk. Our longer-term goal is to distil patterns that can lead to effective (or ineffective) collaborative knowledge construction, which can enable the teachers and us (researchers) to improve on the socio-technical design of lessons (including lesson and activity design, technology re-design, group creation, group composition, classroom space design, and other factors) to more fully exploit the potential of rapid collaborative knowledge building.

Keywords: interactional analysis, rapid knowledge building, collaboration, group cognition

1. Introduction

There is an ever-increasing need to provide students with learning experiences that reflect the challenges and opportunities they will experience in the workforce of the 21st century. One key class of workforce skills relates to rapid collaborative knowledge building (RCKB). RCKB techniques include problem identification, brainstorming, prioritizing, concept mapping, and action planning (DiGiano, Tatar, & Kireyev, 2006). By harnessing these techniques in the classroom, it is possible for students to learn existing concepts deeply and become participants in 21st century knowledge building practices. These techniques can be enacted with light-weight technology such as sticky paper notes (a.k.a. "stickies" or "Post-It" notes or "scribble sheets"), or with digital technologies such as Student Response Systems (SRS). A more sophisticated solution is Group Scribbles (GS), developed by SRI international (SRI, 2006; Roschelle, 2006), which enables collaborative generation, collection and aggregation of ideas through a shared space based upon individual effort and social sharing of notes in graphical and textual form.

We are interested in exploring the harnessing of RCKB in primary (elementary) school classrooms with the use of interactive technologies. Using a design research approach, we are interested to find out if RCKB can improve students' learning as measured by traditional and non-traditional assessments (Ng, Looi & Chen, 2008), and to innovate and test effective pedagogical practices enabled by the electronic version of sticky notes. Many of the pedagogical practices revolve around the use of collaborative group work in the classroom. In our first year of research, we have worked with the teachers to co-design lessons with GS. With data collected, we are interested in analyzing the learning experiences of these groups of students when they interacted with GS and face-to-face.

The rest of the paper is as follows: we will describe how the GS technology supports RCKB in the next section. In Section 3, we review some possible frameworks for analysis of collaborative interaction. In Section 4, we present our current research setting and design. Section 5 discusses the interactional analysis for a mathematics activity using uptake analysis. Section 6 concludes the paper.

2. Technology Support for RCKB

The GS user interface presents each user with a two-paned window. 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 (see Figure 1). The essential feature of the GS client 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. Figure 1 shows a lesson activity in class in which each pupil posts answers to the question "When does the heart beat faster/slower?" in the private board, and then moves their answers to the public board for sharing. The students' Scribble notes showed a multiplicity of ideas they generated which enabled the teacher to initiate discussions on the interesting postings. For example, one student posted "just before examination" in the category of "faster heartbeat", a contribution which surprised the teacher and the class, and which prompted the teacher to initiate a discussion on why this might be the case.

In collaborative classrooms, groups of learners and their teachers routinely work in more complex configurations than lecture-based classes. They take roles, contribute ideas, critique each other's work, and together solve aspects of larger problems, all to good effect (e.g., Hake, 1998; Palincsar & Herrenkohl, 1999). Managed flow of information and control is essential to the structure of many of these successful educational activities (Guribye, Andreassen, & Wasson, 2003).

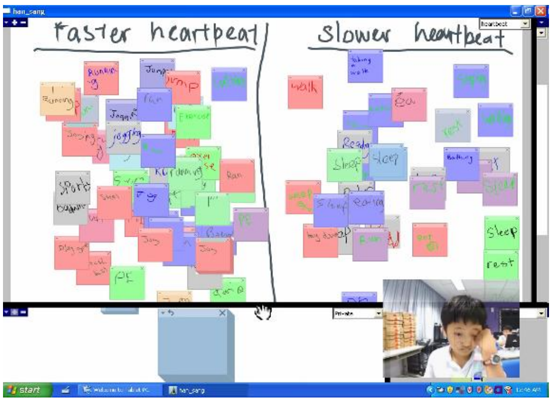

Figure 1: A Morae screenshot of the public or group board (upper pane) and private board (lower pane)

3. Frameworks for Interactional Analysis of Collaboration

In the CSCL community, there is interest in analyzing the interactional processes in online learning environments (Suthers, Dwyer, Medina & Vatrapu, 2007). In analysing interactions in such 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. Traditional psychological methods are limited in addressing the challenges of establishing direct causation between the interaction of independent variables, conditions and the effects of collaboration.

The work of Garcia and Jacobs (1999) adopted the methodology of conversational analysis (Goodwin & Heritage, 1990; Sacks et al., 1974) to study interactions during online conversations. They analysed videotaped recordings of individual participant's computer screens during the sessions that captured the moment to moment interaction. They argued that the use of single point logs to analyze chat transcripts did not sufficiently capture external interaction processes such as the behaviours of participants when using the computer to transmit information (Rintel, Mulholland & Pittam, 2001). One limitation of this research design is the difficulty of administering video capture of participant's screen when students are geographically apart. Garcia and Jacobs' work was adapted by Stahl (2006) to study maths chat interaction in dual-space interaction environments using the concept of turn-taking and adjacency pair. However the sequential nature of posting may disrupt conversational coherence, challenging researchers to identify turn-taking and adjacency pair appropriately. Suthers et al. (2007) developed the methodology of uptake analysis and the notation of uptake graphs to analyse how knowledge building is accomplished in a computer-mediated collaborative environment involving a chat stream and evidence mapping tool. Uptake is the description of the act of a participant taking reifications of prior or ongoing participation as being relevant for further participation in an ongoing process of meaning-making. In this paper, we will explore interactional analysis of intra-group collaboration using concepts from uptake analysis by considering both face-to-face discourse as well as media representations on the GS environment.

4. Research Design and Data Collection

We adopted a design-research approach in our school-based work as we sought to address complex problems in real classroom contexts in collaboration with practitioners, and to integrate design principles with technological affordances to render plausible solutions. Our goal is to conduct rigorous and reflective inquiry to test and refine innovative learning environments as well as to define and refine new learning-design principles (Brown, 1992; Collins, 1992). In our work with a primary (elementary) school in Singapore, two primary 5 classes were involved. Every week for 10 weeks, two lesson periods (totalling an hour and 10 mins) for the subjects of science, mathematics and the Chinese language adopted GS lessons which were conducted in a computer lab. Each pupil has an individual Tablet-PC (TPC) with a GS client software installed. In the previous academic year, these two classes have been involved in Group Scribbles activities for 10 weeks of science lessons, that is, when they were in primary 4. Thus there is substantial enculturation that the teachers and students have gone through to experience RCKB in the classroom.

In our collection of data, 2 or more researchers observed each class and took down detailed field observation notes. One video camera was set behind the classroom to record the classroom session, while two other video cameras were focused on two target groups of students. Screen capturing software Morae 2.0 was installed on the TPCs to record the interaction of the pupils using GS. Taking the perspective of interactional analyses, we attempt to make sense of some of the interactions between students using concepts from uptake analysis and to understand how collaborative experiences are structured as interpersonal interactions sustained over the GS medium and face-to-face talk (Stahl, 2006). In the rest of the paper, we will discuss the analysis of a data segment leading to a group interaction pattern: Group member A learned from another group member B on how to divide a pizza for a specified ratio and how to express the ratio. B and C both posted a graphic note representation, and verbalized over their own notes. A took up the contributions from B, and developed some understanding on how to divide the pizza.

5. Group Interaction in a Math class: Productive Uptakes

This data is from a Primary 5 mathematics class on the topic of finding ratios. The lesson objectives are for the pupils to understand the concept of ratio as a way to show the relative sizes of two quantities, to understand that a given ratio does not indicate the actual size of the quantities involved, and to draw a comparison model to represent two quantities given the ratio. For GS activities, the class is divided into groups of 4 students, and a typical activity would be to get members of each group to work on a common problem. Groups can also comment on other groups' solutions. For the purposes of this paper, we focus on the interactions of one target group of students who were seated next to each other. In this way, we can observe the students' talk over their GS representations as well as their verbal talk.

In this class lesson, the first activity on GS was to have each group of pupils practise writing a ratio given two sets of items (e.g., 3 shirts to 2 pants, 4 pencils to 5 erasers, etc). The group we are observing comprises 4 students Tai Yew, Hwee Zhu, Yong Hao and Qiang Xing. Figure 2 shows their seating arrangements. Figure 3 shows a screenshot of the group board that the group worked on. The ratio activity requires each group to work out the ratio when dividing 2 pizzas amongst 3 children. Each of the 4 students in this group is asked to do their individual work, either thinking about the solution or creating their private GS note and then posting onto the group board. Each student creates notes in his or her private board (not shown), and then moves them to the group board which can be shared, viewed and manipulated by other team members. The members of the group are expected to discuss their individual solutions within the group.

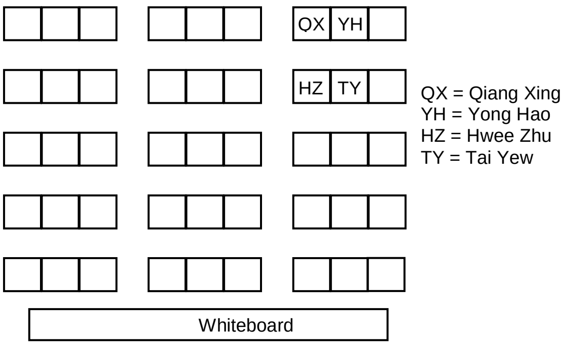

Figure 2. Seating arrangement of group for the math class/activity

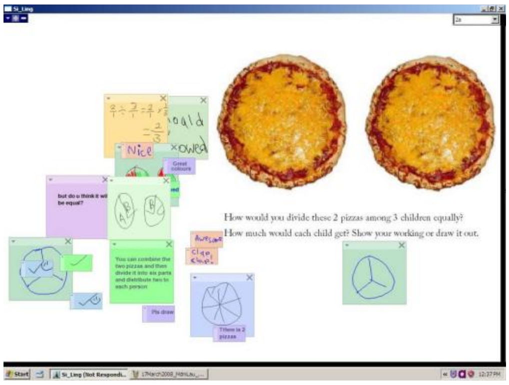

Figure 3. A screenshot of the group board (with the private board hidden)

Figure 4 shows the flow of actions and interactions of the 3 students. Stahl (2006) uses a diagram of the responses of the postings in a chat between 3 participants in a chat environment in which the postings of each participant are placed in chronological order in a column for that individual. Stahl uses solid arrows to indicate his notion of math proposal adjacency pairs and dashed arrows to indicate other kinds of responses. For our work, after analysing several group interactions, we propose five types of responses: (1) agreement on a media event: one agrees with an idea that was suggested by another person; (2) agreement with improvisation of a media event: one comes up with a better idea building on the previous media event; (3) disagreement on a media event: one shows disagreement with what someone has proposed; (4) incomprehension of a media event: one does not understand or comprehend what someone was trying to express; (5) dependent relationship between media events: none of the above, but there is clearly some kind of evidence of media dependencies, representational association and semantic relatedness (Suthers, Dwyer, Medina & Vatrapu, 2007).

The activity in our targeted group commences as follows: Tai Yew drew a circle, and then undid the action as he verbalized his reasoning (refer to Figure 4, T1-T3). Concurrently, Hwee Zhu and Yong Hao posted notes that showed a graphical way of dividing the pizzas. Hwee Zhu created 2 notes showing the division of each pizza into 3 equal parts, and then directed Tai Yew to the notes (Figure 4, H1 and H2). Yong Hao also drew two circles in one note, with divided parts for 3 imaginary persons, A, B, and C. We knew that Yong Hao is a smart student, and he drew the note after he figured out the answer of 2/3 (Figure 4, Y1). Yong Hao told Hwee Zhu that his was a "short-cut" solution to the problem (Figure 4, Y2 & Y3). Hwee Zhu interrupted Yong Hao and emphasized her own explanation (Figure 4, H3). At this point, temporal proximity is evident as Tai Yew made a quick comment "Oh ya, she is right" after he understood Hwee Zhu's solution (Figure 4, T4).

In essence, Hwee Zhu posted two GS notes showing her understanding of how to divide a pizza into 3 pieces. Tai Yew uptakes the contributions from Hwee Zhu, and developed some understanding on how to divide the pizza. He tried to divide his pizza in a similar way but could not replicate the division, and so he typed his answer out in text. While Tai Yew developed an understanding on how to divide, he was not able to replicate or express in a pictorial format (Figure 4, T5). The GS notes do provide a multiplicity of expressions, as Tai Yew could not express his understanding in a visual way, but was able to type out his understanding in a textual way (Figure 4, T6). From Tai Yew's textual post, there is evidence of semantic similarity where Tai Yew's final method of combining the two pizzas and then dividing into the 6 slices is his interpretation of Hwee Zhu's explanation of "having each pizza divided into 3" to him. Tai Yew's attempt to "distribute two to each person" on his post was derived from Hwee Zhu's idea of "each person get two" as well. Tai Yew's finalised answer was the evidence of uptake from Hwee Zhu's and it was different as compared to his original attempt in decimals initially. We see this uptake as an instance of uptake across the representational space. Yong Hao developed his own solution representation which was less decipherable than Hwee Zhu's solution, and stuck to his own solution. He might have perceived the query posted to him, namely, "?" as irrelevant as he thought his solution was correct (Figure 4, Y4).

Although both Hwee Zhu and Yong Hao both proposed solutions on dividing the pizza, Hwee Zhu's proposal was verbalized and taken up by Tai Yew while Yong Hao was not developed further. We see this as an instance of an uptake across people. Hwee Zhu's proposal can be considered a pivotal contribution (Wee & Looi, 2008) because of its potential affordance of knowledge construction offered to the group. Yong Hao's proposal seems to lack clarity and he did not actively attempt to engage the others to explain his proposal. Both proposals offer different approaches and are mathematically correct. However, it will be useful to find out how Yong Hao's failed proposal could have been developed by other members.

Each student relied on their own individual work even though they discussed as a group. Tai Yew wanted to re-create his own solution after he has seen Hwee Zhu's solution. We see Tai Yew's effort as an imitation routine where he tries to individualize the understanding as his own ability (Sfard, 2008). The way the group approached this problem is for each of them to individually craft their solution or solution steps, and then discuss and learn from each other. This has been one pattern of activity design for group work on GS. The current class seating arrangements is still like that of a traditional class (see Figure 2) which is constrained by the network cabling to the students' Tablet PCs. Tai Yew and Hwee Zhu are seated next to each other, facilitating their more frequent verbal interactions; Hwee Zhu and Yong Hao who was seated a row behind also interacted verbally. In subsequent work, we will adopt a seating arrangement more conducive to group collaboration where members of a group are co-located and face each other.

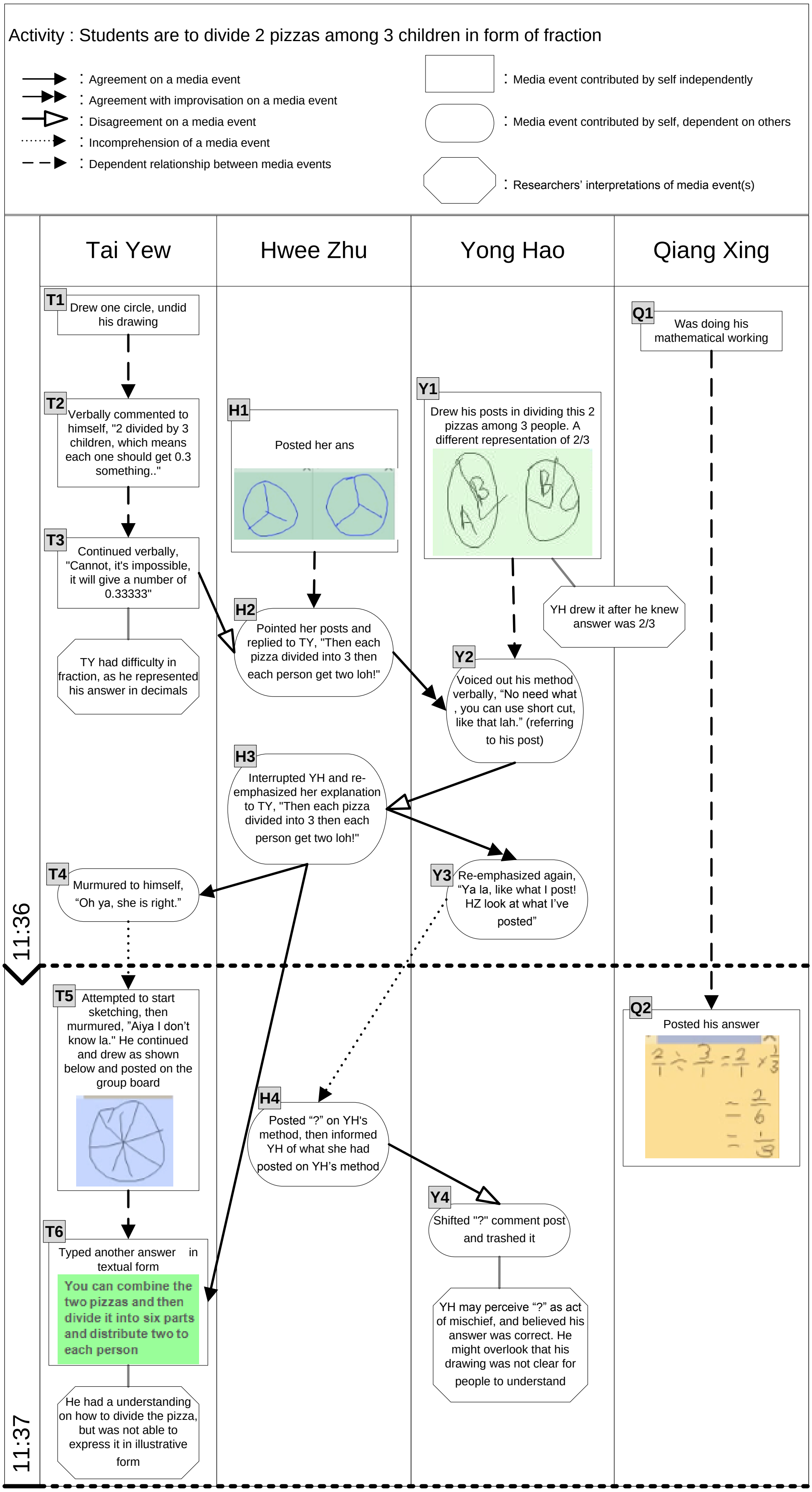

Figure 4. Intra-Group Interaction in a math activity

The group interaction happened very fast, in about 2 minutes. We like to see these intra-group collaborations in the classroom as moving them towards practices of doing RCKB. Hwee Zhu and Yong Hao started with visual representations and talked over it. This activity shows that the uptakes are more contingent on the voice-over articulations together with the visual representations, more than just the visual representations themselves. This activity also suggests that there is something to be gained by putting the students in a group sitting to each other, rather than seated apart which allows collaboration strictly through the technology medium, unless the members of a group move about in the class to talk to their team members.

Subsequent potential evidence that Tai Yew's update has improved his understanding was found during the subsequent activity in the same class session where he was able to comment and critique on two other group's solutions for a different ratio problem (Figure 5). Qiang Xing's GS posting (Figure 4, Q2) showed a mistake in his answer. At that point of time, he did not notice it, as none of his group mates posted a similar numerical answer as his. He realised his careless mistake and amended it eventually when he spotted a similar representation, but of a different answer on another group board. We see these as instances of uptakes across time. Indeed the teacher told us that she realized that after conducting this activity, she observed that there was not enough clarity in what constitutes the whole in formulating the fraction, and that some students did have problems with expressing the mathematical notation for the part-whole concept. Hence, she re-emphasized the correct concept to her students at the end of that GS lesson and the subsequent mathematics lesson. She made use of this feedback to refine her preparation in conducting the same lessons for the other classes as well, as she anticipated such similar mistakes could also happen to her other classes.

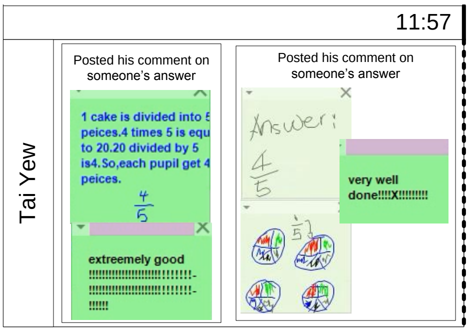

Figure 5. Comments by Tai Yew

6. Conclusion

We are interested in exploring various frameworks in supporting analysis of collaborative knowledge building through the media affordances of GS as well as the face-to-face interactions mediated by the GS artifacts. In this work, we adapted Suthers, Dwyer, Medina & Vatrapu's uptake analysis framework (2007) and proposed the use of five types of responses. In this one episode, we shared some instances of how the five types of responses are identified. In the episode on mathematics where the students are learning representational notations for fractions and ratios, there was uptake that helped at least a member of the group to further develop his understanding. We identified instances of uptakes which were carried across representational spaces, people and time. The responses identified in this work represent our current emerging findings for representing uptakes in a GS environment. In ongoing work, we will analyse more interaction data from-intra group collaboration as well as inter-group collaboration problem solving episodes, and further develop key ideas addressed in this paper.

Acknowledgements

This material is based on work supported by a grant from the National Research Foundation, Singapore. We wish to thank SRI International for providing a license to use the GS software in Singapore, and Jeremy Roschelle, Charles Patton, Dan Suthers and members of our GS team for sharing their valuable insights and perspectives with us. We are grateful to Mayflower Primary School for collaborating with us on this research.

References

[1] Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141-178.

[2] 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.

[3] Collins, A. (1992). Towards a design science of education. In E. Scanlon & T. O' Shea (Eds.), New directions in educational technology (pp. 15-22). Berlin: Springer.

[4] 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. http://Group Scribbles.sri.com/publications/index.html.

[5] 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.

[6] Garcia, A.C., & Jacobs, J.B. (1999). The Eyes of the Beholder: Understanding the Turn-Taking System in Quasi-Synchronous Computer-mediated Communication. *Research on Language and Social Interaction, 32 (4)*, 337-367.

[7] Goodwin, C., & Heritage, J. (1990). Conversation Analysis. *Annual Review of Anthropology, 19*, 283-307.

[8] Guribye, F., Andreassen, E. F., & Wasson, B. (2003). The organisation of interaction in distributed collaborative learning. In B. Wasson, S. Ludvigsen & U. Hoppe (Eds.), *Designing for change in networked learning environments* (pp. 385-394). Boston: Kluwer.

[9] Hake, R. R. (1998). Interactive-engagement vs. traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66, 64-74

[10] Foo-Keong Ng, Chee-Kit Looi, Wenli Chen (2008). Rapid Collaborative Knowledge Building: Lessons Learned from two Primary Science Classrooms. Paper presented at the International Conference of Learning Sciences (ICLS '08), Utrecht, Netherlands.

[11] Palincsar, A. S., & Herrenkohl, L. R. (1999). Designing collaborative contexts: Lessons from three research programs. In A. M. O'Donnell & A. King (Eds.), *Cognitive perspectives on peer learning* (pp. 151-177). Mahwah, NJ: Lawrence Erlbaum Associates.

[12] Rintel, E. S., Mulholland, J., & Pittam, J. (2001). First things first: Internet relay chat openings. *Journal of Computer-Mediated Communication, 6(3)*.

[13] Roschelle, J. (2006). GroupScribbles: A tool for highly interactive Tablet PC classrooms *Presented at the HP Webinar on Teaching, Learning, & Technology in Higher Education.*

[14] Sacks, H., Schegloff, E. A., Jefferson, G. (1974). A Simplest Systematics for the Organization of Turn-Taking for Conversation. *Language*, *50*, 696-735.

[15] Anna Sfard (2008). *Thinking as communicating: Human development, the growth of discourses and mathematizing*, Cambridge University Press.

[16] SRI International. (2006). http://Group Scribbles.sri.com/

[17] Stahl, G. (2006). Sustaining group cognition in a Math chat environment. *Research and Practice in Technology Enhanced Learning (RPTEL)*, 1 (2).

[18] 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.

[19] Stahl, G., Wee, J. D., & Looi, C.-K. (2007). Using chat, whiteboard and wiki to support knowledge building. *Paper presented at the workshop on "Knowledge Building Research in Asia Pacific" at the 15th International Conference on Computers and Education (ICCE 2007)*, Hiroshima, Japan.

[20] 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.

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

[22] Suthers, D. D. Dwyer, N., Medina, R., & Vatrapu, R. (2007). A framework for eclectic analysis of collaborative interactions. In C. Chinn, G. Erkens & S. Puntambekar (Eds.), *The Computer Supported Collaborative Learning (CSCL) Conference 2007* (pp. 694-703). New Brunswick: ISLS.