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# Analysis of Group Understanding in Artifact-Mediated Discourses

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**Abstract:** A collaborating group is increasingly viewed as a cognitive unit, the workings of which need to be understood independent of its effects on individual learning. We are beginning to understand how groups operate as a cognitive unit that learns, solves problems, and/or constructs new knowledge, but still lack adequate conceptual frameworks and analytic strategies to deal with different dimensions of group cognition. This problem is particularly acute in small group interaction mediated by technologies. While various technological tools are used to support small group interaction, we do not understand clearly yet how group understanding emerges from this process. In this paper, we examined the development of group understanding when the group discourse is mediated by the construction of technological artifacts.

## Introduction

While interest in collaborative learning initially started as a way to promote students' individual learning, a collaborative group is increasingly viewed as a cognitive unit, the workings of which need to be understood independent of its impact on individual learning (Stahl, 2010; van Aalst, 2009). In real life, small group function as a unit of information processing in team performance (e.g., ship navigation), knowledge production (e.g., research teams), and creativity (e.g., theatrical production). Treating the group as a unit means more than using it as a unit of coding and analysis. It means that a group needs to be considered as an agent whose properties are independent from its individual members (Hutchins, 1995). It consists of individuals, but its characteristics and behaviors may not necessarily follow those of its individual members. In this paper, we define group understanding as what the group knows as a whole and explore how it develops over time through interaction.

Small group interaction is typically mediated by verbal discourse. Existing discourse analysis methods heavily rely on the analysis of verbal discourse data. However, with the advent of information technology, collaboration is increasingly mediated by various technological tools. In this paper, we explored the development of group understanding when their interaction was mediated by technology. We take the artifacts group constructs as a proxy for group understanding (Jeong, in press) and examined how group understanding, in the form of contributions to the group workspace, evolved over time as its members share their ideas, elaborate on each other's contributions, and make sense of the different conceptions arising from the discourse.

## Research Context and Data Sources

The data were drawn from a school-based research project about classroom collaborative knowledge building practices through the routine use of a networked technology called GroupScribbles (GS). A fifth grade class (about age 11) in a primary (elementary) school in Singapore participated in the project. In one of the activity called as "Fraction Division," students were asked to work out a ratio when dividing two pizzas equally among three children. The objective of the lesson was to understand the concept of ratio as a way to show the relative sizes of the 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 the two quantities given the ratio. Students worked in groups of four. They were first asked to work individually, either thinking about the solution or creating their private notes, and then to share it with the rest of the group. Members of the group were expected to discuss their individual solutions within the group and to arrive at some consensus. Students were also expected to interact with other groups. The GS tool provides workspaces for students in the form of private and public boards presented in a two-paned window. The lower pane of the GS was the user's personal workspace or private board where students worked individually. The upper pane of the GS was the group boards or public workspace. Students could create posts in their private space, and then move them to the group space where they can be viewed and commented by other students. Students could also access the public spaces of other groups and copy and publish notes (see Looi et al., 2010, for more detailed description of the curriculum and the technologies).

There were ten groups in the class. We randomly chose one group, Group 2, as our target group. The target group comprised of four students: Terry, Victor, Helen, and Quentin (all pseudonyms). Although they did not face each other, they sat in pairs over two rows and thus could talk to the student seated next to them. One video camera was set behind the classroom to record the whole classroom, while another camera recorded the target group. A screen capturing software was installed on each student's Tablet PC and recorded students' on-

screen activities, verbal utterances, facial expressions, and non-verbal behaviors. The activity lasted about 16 minutes.

## Analyses

An earlier analysis of this data was carried out from the perspective of uptake analysis (Looi & Chen, 2010). In this paper, we examined the data from the perspective of how group understanding develops through artifact-mediated discourse. Our analyses focused on the following two issues. First, we examined the development of group understanding with respect to the solution to the ratio problem. This was done based on the analysis of the artifacts students created during the activity, that is, the contents of the group workspace. We analyzed the kinds of contributions students made in the group's public space and traced how it has changed over time. Second, we analyzed the discourse around the artifacts to identify how verbal utterances and non-verbal activities in the GS environment have contributed to the construction of the artifacts.

### Artifacts: Postings and Contributions

Most of students' contributions to the group space consisted of post-it notes in the form of drawing or texts. Once published, postings can interact in that students can publish notes related to what others have already contributed. In order to identify postings that 'interacted', we grouped individual postings into contributions. While *postings* refer to individual notes or drawings that students published, *contributions* refer to a set of postings grouped around the same core ideas. Additions, improvements, and revisions of the existing posting were considered as one contribution. For example, if a student put a check mark on top of existing drawing (indicating approval of the drawing) or if a student divided the pizza in certain ways and then put a post-it with the same drawing on top of the existing drawing, they were considered to belong to the same contribution. Contributions may consist of single posting, if there was no follow-up posting, or of several different postings. Using the videos and transcripts, we examined and identified postings students created during the activity. Both task-related and task-unrelated (e.g., packmen drawings) contributions were coded. The authors of the contributions were also coded. Whenever there is a change in the contents of the group workspace, we coded it as a separate state of the group space and coded the contributions involved in the change. A state change typically involved an addition or removal of a single posting, but could involve multiple postings as multiple students often published and/or arranged notes in the group space at the same time.

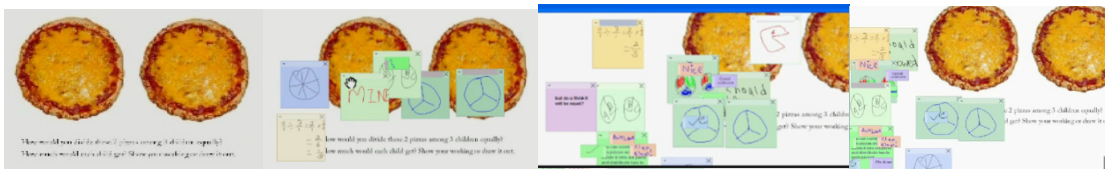
### Artifact-Mediated Discourse: Verbal and Non-verbal Activities

In GS environments, discourse not only consists of verbal activities but also non-verbal activities. Verbal activities refer to utterances either directed to oneself or to other students. Non-verbal activities refer to gestures, behaviors (e.g., raising hands to get attention; glancing at other students' screen) or actions in GS environment (e.g., actions such as publishing and trashing of notes, drawing and erasing of drawing, moving and rearranging notes were all coded as relevant activities). In order to examine how these discourse activities contributed to the construction of artifacts, we identified verbal and non-verbal activities that occurred around each contribution. There were a number of off-task or task-unrelated activities in the transcript and the video such as talking about one's speaker and starting off the GS program. Such activities were not coded unless they were related to one of the contributions identified in the artifacts coding. For each activity, we coded the 'owner' of the activities.

## Results

### Evolution of the Group Space

Group space evolved steadily as students added contributions to the group space. Thirteen contributions were made to Group 2's public space. The group space started with two blank pizzas (Figure 1a), but quickly grew into a state with several contributions including some task-unrelated contributions (Figure 1b and 1c) and to its final state (Figure 1d).



(a) (b) (c) (d)

Figure 1. Evolution of the Group 2's Public Space.

Including the initial and final states, the group workspace has undergone 61 different states. Figure 2 shows when each contribution first appeared and/or disappeared over the 61 states (the break toward the end

indicates a computer crash). The group space that began with zero contribution in the beginning contained six contributions (C2, C3, C4, C6, C9, & C13) at the end (State 61). After initial postings were made, contributions underwent some changes throughout the episode. These involved reworking and revision of one's own posts, publishing of comments on existing contributions, or rearranging of posts, and in some cases, removal of posts. For example, a contribution (C6) appeared early on in the episode (State 9), disappeared later from the public space when the student wanted to make a change in the post (State 51) but soon reappeared (State 53), and remained in the group space till the end. The contribution (C1) stayed in the group board over two states, but quickly disappeared. Of the 13 contributions published in Group 2's public space, slightly less than half of them (46%) remained in the public space till the end. Most of the contributions disappeared were task-unrelated contributions, but two of the task-related contributions also disappeared from the group space. In one case (C7), an unidentified student made an 'accidental' contribution in Group 2's group space, but removed it quickly (State 16 & 17). In another case (C12), Helen published a post with two circles each divided by four (State 27). It was not a correct solution. It appears that she was trying things out and removed the post because she was unsure about it (State 29).

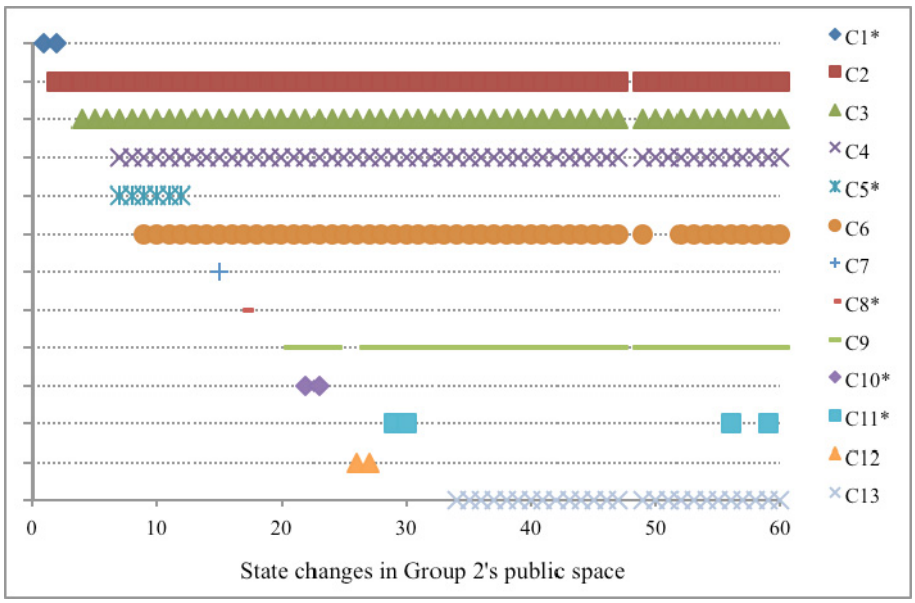
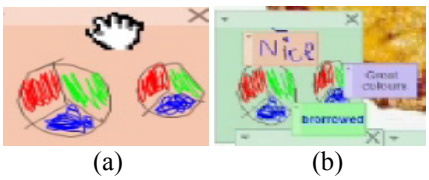



Figure 2. Contributions in the group workspace (Contributions with asterisk were task-unrelated contributions).

## Emergence of the Contributions

Contributions emerged through artifact-mediated discourse, often over many activity sequences. For example, the last contribution in the Group 2's workspace (C13) was made by Helen when she checked on another group's work. Helen was checking out other groups' workspaces and noticed a colored pie drawing (Figure 3a). Since she did not know how to put color to pie charts, she copied the drawing and published it in her group's workspace. She did not alter the drawing except changing the color of the note from orange to green. She put "I borrowed" note on top of her drawing, indicating that she did not come up with the solution herself. This 'borrowed' contribution later received a few feedbacks (e.g., "nice", "great colours") from other students (Figure 3b).




(a) (b)

Figure 3. (a) The posting that Helen took from Group 1a's public workspace. (b) Helen's contribution to her own group's workspace at the end of the episode.

To be precise, this contribution emerged from the following sequence of activities (Helen also posted "I borrowed' and "thx" to Group 1's public space, but they were not included in the analysis since they were contributions outside of Group 2's space):

1. Helen went to Group 1a's public space and saw a posting with 3 different colors (Figure 3a).
2. Helen said: "Wow, how did they color it?"

3. Helen took the post from Group 1a's public space to her private workspace.
4. Helen cloned the post.
5. Helen put the post back to Group 1a's public space.
6. Helen changed the color of the cloned post in her private workspace from red to blue.
7. Helen moved the post to her own group's public workspace.
8. [pause] An unidentified student (from another group) put a comment "nice" on top of her post.
9. [pause] Helen posted a little post saying "I borrowed" on top of her post.
10. Another unidentified student put a comment "Great colours." (Figure 3b)

For each of the contributions in Group 2's public space, we examined how it has evolved over time. As can be seen in the above example, contributions emerged from both verbal and non-verbal activities. That is, unlike typical discourse, the interaction in GS environment was mediated both verbally and non-verbally through what the students posted in the public space. On average, about one third of the contributions (29%) were verbal in the form of self-talks or dialogues, and the rest (71%) were non-verbal activities in GS environments (Table 1). It appears that non-verbal activity, mostly in GS actions, supplemented the need for talk and became the dominant mode of discourse.

Table 1: Mean verbal and non-verbal activities per contribution.

| | Activities | | |
|---|---|---|---|
| Contributions | All | Verbal | Non-verbal |
| Task-related (N=8) | 11.13 | 3.63 (33%) | 7.50 (67%) |
| Task-unrelated (N=5) | 12.00 | 3.00 (25%) | 9.00 (75%) |
| All (N=13) | 11.46 | 3.38 (29%) | 8.08 (71%) |

Contributions not only evolved over multiple activities but also over multiple contributors. Contributions in Group 2's workspace were examined in terms of who has carried out the individual activities that contributed to them. If only one student's talk or activities were involved in the evolution of the contribution, it was considered as individualistic contributions. If more than one student was involved, then the contribution was considered to be collaborative. In the case of contribution in Figure 3 (C13), for example, it was considered as a collaborative contribution because Helen got her post off of another group's space and also because of the comments made by two unidentified students. Of the 13 contributions in Group 2's public space, more than half (54%) were individualistic contributions and the rest (46%) were collaborative contributions (Table 2). Task-related contributions tended to be more collaborative than task-unrelated contributions. There was one task-unrelated contribution that was collaborative. It occurred when one student in Group 2, Victor, got bored and posted several "MINE" notes all over the group board. When other students saw these posts, they grabbed and trashed them, saying "get rid of mine". Thus, they did not participate in his off-task behavior, but instead collectively censored his disruptive postings in order to regulate the group board.

Table 2: Frequency (percentage) of individualistic and collaborative contributions.

| | Individualistic | Collaborative |
|---|---|---|
| Task-related (N=8) | 3 (38%) | 5 (62%) |
| Task-unrelated (N=5) | 4 (80%) | 1 (20%) |
| All (N=13) | 7 (54%) | 6 (46%) |

Task-related contributions tended to be collaborative. However, while they were collaborative in the sense that students talked about them and posted evaluative comments and feedback about the contributions, the quality of the interaction remained on the shallow side. Students would put question marks or check marks on others' postings, but substantive comments were rare. In addition, questions and comments were not followed through, so that question marks or comment such as "there are two pizzas" (about a post with only one pizza) went on unanswered. Similarly, relationships between different solutions were never discussed. Solutions in the form of drawings and formulas were not integrated. Students did not organize their public knowledge except for occasional rearrangement of posts. It should be noted, however, that the whole activity lasted 16 minutes, not enough time for such interactions to unfold.

## Discussions

In this study, we examined how group understanding can be assessed when interaction involves the construction of artifacts. We took the artifacts created by the group as a proxy for the group understanding and examined how it evolved over time. The results showed that group understanding, as reflected in the contents of the group space, experienced changes as individuals share their ideas, elaborate on each other's contributions, and make

sense of the different conceptions arising from the discourse. Contributions, once made, were subject to comments and revisions, and in some cases removal. While the understanding evolved to include several correct solutions to the problem, the 'quality' of the group understanding was not high. For the group to develop its understanding, the group needs to engage in accommodation as well as assimilation (Cress & Kimmerle, 2008). In this study, the students actively shared and interacted over postings. In the process, the group assimilated different knowledge and the group representation grew in size. However, the group did not carry out much reorganization or synthesis of the knowledge they assimilated. Little accommodation occurred, and as a result, group understanding remained fragmented, mostly as a collection of individual contributions.

The analysis also examined how each contribution emerged from artifact-mediated discourse. The majority of the contributions were collaborative, but the collaboration was mediated by both verbal and non-verbal activities in the GS workspaces. Although students interacted verbally over contributions, the majority of the interaction occurred in the form of comments and checkmarks on the contributions. As they could respond by posting comments and notes, there was less need to interact verbally. Dillenbourg and Traum (2006) examined grounding and problem solving in a multi-modal computer mediated learning environment. They examined how a shared white board and a chat tool in MOO environment were used for grounding and noted that acknowledgement rate varied across media and content. They reported that the whiteboard was used to represent the state of the problem and the chat was used to ground information (Dillenbourg & Traum, 2006). While the present study involves different modalities and tools, it appears that when interaction is distributed over different modality and media, different media may take on different roles in interaction (Chen, Looi, & Tan, 2010). More research is needed to understand how artifact-mediated discourse might differ from verbal discourse and the role different technologies may serve in this process.

In summary, the work reported in this paper provided a descriptive account of interaction of a collaborative group activity in the context of a real classroom lesson. In this environment, the discourse was mediated by GS artifacts and often took the form of activities as students responded to other students' contributions by providing additional artifacts. Tools such as GS can support the construction of group understanding a great deal. It supports students' cognitive interactions by making the artifacts visible and persistent so that everybody can easily see what has been accomplished by all members (Chen, et al., 2010). Group accomplishments build on the individual contributions. A small contribution by an individual, while it may appear insignificant by itself, can further the progress of the group in critical ways. In this study, we provided an analysis of how group understanding evolved from the interactions between students and between students and artifacts. As we carried out our analysis, we feel that we are encroaching into a space where there are enormous conceptual and methodological challenges and opportunities and urge other researchers to participate in this exciting process of advancing our understanding about group cognition.

## References

Chen, W., Looi, C. K., & Tan, S. (2010). What do students do in a F2F CSCL classroom? The optimazation of multiple communications modes. *Computers & Education, 55*(3), 1159-1170.

Cress, U., & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with wikis. *Computer-Supported Collaborative Learning, 3*, 105-122.

Dillenbourg, P., & Traum, D. (2006). Sharing solutions: Persistence and grounding in multimodal collaborative problem solving. *The Journal of the Learning Sciences, 15*(1), 121-151.

Hutchins, E. (1995). *Cognition in the wild.* Cambridge, MA: The MIT Press.

Jeong, H. (in press). Verbal data analysis for understanding interactions. In C. Hmelo-Silver, A. M. O'Donnell, C. Chan & C. Chinn (Eds.), *The International Handbook of Collaborative Learning*. London: Taylor and Francis.

Looi, C. K., & Chen, W. (2010). Community-based individual knowledge construction in the classroom: a process-orientation account. *Journal of Computer Assisted Learning, 26*(3), 202-213.

Looi, C. K., Chen, W., & Ng, F. K. (2010). Collaborative activities enabled by GroupScribbles (GS): An exploratory study of learning effectiveness. *Computers & Education, 54*, 14-26.

Stahl, G. (2010). Group cognition as a foundation for the new science of learning. In S. K. Myint & I. M. Saleh (Eds.), *New science of learning: Cognition, computers and collaboration in education*.

van Aalst, J. (2009). Distinguishing knowledge-sharing, knowledge-construction, and knowledge-creation discourse. *International Journal of Computer-Supported Collaborative Learning, 4*, 259-287.

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