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Exploring Interactional Moves in a CSCL Environment for Chinese Language Learning

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Abstract: This work analyzes the interactions of small groups of students doing collaborative learning activities in the primary classroom for learning Chinese as a second language. We take the perspective of identifying the characteristics of interactional moves as students interact and negotiate meaning in the computer-mediated collaborative learning (CSCL) environment called GroupScribbles (GS). Much work in group cognition and in interactional analysis of small groups looks at problem-solving in subjects like mathematics and science. In language learning, the task posed for collaborative activities does not focus on problem-solving, but it may be targeted towards enriching students' vocabulary and proficiency in language expression, developing their thoughts and writing through cogitating with new words, vocabulary and sentence construction. We hope the work can illuminate how students can co-construct knowledge mediated by GS representations for Chinese language learning. In the paper, we look at collaborative situations in which the group members are not seated together in the classroom, and so they have to collaborate through the GS medium.

Introduction

Chinese is a character-based language. To be literate in Chinese, one needs to know over a thousand Chinese characters (Wing, et al., 2003). In Singapore, English is the language of instruction in schools, and Chinese students learn Chinese as a second language (L2). The Singapore Ministry of Education (MOE) census reports that the most frequent reason which is cited by Singapore primary students to indicate that they do not like to learn Chinese is the great amount of Chinese words to memorize (MOE, 2004). From the perspective of linguists, the Chinese script, due to its logographic nature, is considered the most difficult script to learn by non-native learners (Shen, 2004).

Studies have been conducted concerning the level of cognitive processing and its impact on word learning and memory in logographic languages for a long time. Innovations in language education have been targeted towards a more comprehensive understanding of the development of children's capability in handling the script of Chinese, and ways of enhancing learners' structural understanding of the writing system beyond rote learning and mechanical practice (Tse, 2001, 2002). Along with developments in computers and virtual reality, explorations of the potential roles of integrative computer-assisted Chinese learning (CACL) have begun to emerge in the literature. Current research pays more attention to human-computer interaction, mainly ranging from the web-based synchronized multimedia lecture system for Chinese as second language (L2) learners (e.g., Chen & Liu, 2008) to the concrete on-line classroom teaching and learning which emphasizes Chinese course design and pedagogical frameworks. Examples of research efforts include the effects of on-line peer assessment upon Chinese writing in Taiwan primary school (Wang et al., 2007). Our literature search reveals little research in CSCL for Chinese (L2) learning. Thus, there exists a gap in research on how group students collaboratively work in on-line environment of Chinese lessons, and how group students achieve their knowledge/ideas sharing and co-construction in Chinese language learning.

In our work, we explore the use of a collaborative technology to support rapid knowledge building in the classroom. GroupScribbles (GS) 2.0 is co-developed by SRI International and Learning Sciences Lab of National Institute of Education Singapore, 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. One of the key principles in the GS environment is that the notion of lightweight GS notes or contributions in which each student only can express in one word or at most few words on a small GS note. This offers the potential for learning and understanding new words and the development of thinking skills in a dynamic and rapid collaborative classroom environment for L2 learning. In the past year, we have co-designed GS lessons with the teachers, and observed over 50 classroom lessons for the subjects of science, mathematics and Chinese language learning. We noticed that the process of collaboration happened in Chinese language learning has its own characteristics, compared with collaborative activities for science and mathematics. In this paper, we analyse two episodes of GS activity applied for Chinese language learning to illustrate how students build on each other ideas in group collaborative language learning. We attempt the perspectives of identifying patterns of communication or representational practices (Medina, Suthers, & Vatrapu, 2009). These practices are joint practices developed in the emergent interaction of group members and shared by the members, practices

which related to the methods for generating, manipulating and interpreting inscriptions that the group developed for handling a class of problems (Enyedy, 2005; Kozma & Russel, 2005; Roth, 2003).

Technology Support for Collaborative Learning

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 (Ng, Looi, & Chen, 2007). Students can choose anyway which they feel comfortable to express their ideas, through typing, writing by stylus or even drawing on the pad, and then post the pad onto the public board to share with others. After logging in, any students can browse all others postings posted on the public board.
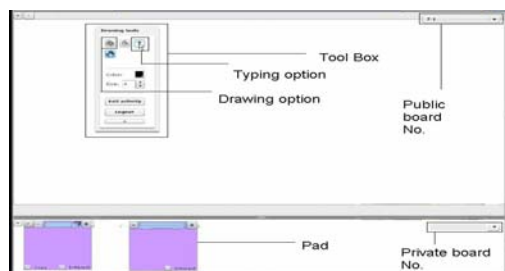

Figure 1. Interface of GS 2.0

Research Framework

A design-research approach is adopted in our school-based work in order to address complex problems in real classroom contexts in collaboration with practitioners. In this work, a higher Chinese language class in elementary grade 5 from a neighborhood primary school was involved. The 39 students in the class were divided into 10 groups. In the GS classroom each pupil was equipped with an individual Tablet-PC (TPC) with a GS client software installed.

When collecting data in classroom, 3 or more researchers observed each class and took down detailed field observation notes. Video camcorders were placed at the back of the classroom to record the overall classroom happenings. All the classroom talks were transcribed. The screen capturing software Morae 2.0 was installed on the Tablet PCs of all the computers in one group to capture the process of each student's work on the Tablet PC and their verbal talks and facial expressions. As for the analysis of the target group's interactions, researchers watched the video captured by Morae for the each members of the group, and transcribed the actions carried out by them. The actions included how pupils worked individually and collaborated on the tasks through making artifacts on GS, GS-based or verbal conversation and physical gestures etc.

We need to adopt a notation for representing flow of actions and interactions of the 4 students who are work in the same group. 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 analyzing several group interactions, we propose five types of responses (Looi et al., 2008) : (1) agreement on a contribution: one agrees with an idea that was suggested by another person; (2) agreement with improvement of a contribution: one comes up with a better idea building on the previous contribution; (3) disagreement on a contribution: one shows disagreement with what someone has proposed; (4) incomprehension of a contribution: one does not understand or comprehend what someone was trying to express; (5) other dependent relationship between contributions: none of the above, but there is clearly some kind of evidence of media dependencies, representational association and semantic relatedness (Suthers et al., 2007).

For the first type of response, agreement on a contribution, one agrees with the idea that was suggested from the other. Here is an example of such a response from A to B's idea:

        A: What shall we do to this sick ferret?
        B: How about bringing it to the vet?
        A: That is a great idea!

For the second type of response, agreement with improvement of a contribution, one comes out with a better idea based on the original one from the other, besides agreeing on that. Here is the example for such a response:

        A: What shall we do to this sick ferret?

> *B: How about bringing it to the vet?*
> *A: That's great! Maybe after that we can ask the vet to recommend a place for the ferret to recuperate as well?*

For the third type of response, disagreement on a contribution, one is disagreeing with the idea proposed by the other instead. An example for such a response will be:

> *A: What shall we do to this sick ferret?*
> *B: How about bringing it to the vet?*
> *A: I think it will be too late. The ferret is going to die soon.*

For the fourth idea, incomprehension of a contribution, one is not able to understand or comprehend what the other was trying to express. Here is the example for such response:

> *A: What shall we do to this sick ferret?*
> *B: This ferret needs an operation.*
> *A: Huh? What do you mean by that?*

The last type is none of the above, but there is evidence of uptake, referencing or relatedness. For example, A decides to take a bus to look for a vet, after A and B agree verbally to bring the ferret to a vet. So, the action taken by A (taking a bus to look for a vet) is a contribution that is dependent on another contribution before that (which is the verbal agreement by A and B). In the charts of Figure 3 & 4, the five types of responses are represented by different sort of arrows respectively.

Medina, Suthers and Vatrapu (2009) analyze the interaction of a small group working on mathematics problems over several days in a synchronous computer-mediated communication environment consisting of a whiteboard and a chat tool. They trace the formation, transformation, and refinement of one problem solving practice – problem decomposition—and three representational practices—inscribe first solve second, modulate perspective, and visualize decomposition. Stahl (2009) in reviewing Sfard's book says that imitation of practices is an integral part of the process of group cognition in mathematics learning. Motivated by Medina, Suthers and Vatrapu (2009), we are interested in the myriad of ways each group of students interact each time it "cogitates" about a given problem. In a knowledge building environment like Knowledge Forum and for a science discussion, we will see many interactional moves will have the nature of idea refinement, seeking to develop better conceptions of an idea. In a knowledge building environment for mathematics problem solving, we expect to see interactional moves that have the nature of making, accepting, rejecting or modifying proposals or steps to solve the problem. Our context is learning a logographic language like Chinese, and thus we are interested in the nature of interactional moves in a loosely constrained representational and collaboration environment like GroupScribbles. The contribution we hope to make in this paper is to hone the methodology to unpack process-oriented accounts of group collaboration in Chinese language learning from the perspectives of interactional moves or patterns.

GS Activities Design in Chinese Language Classes

The GS activities of Chinese Language range from learning new words/phrases, reading comprehension to writing compositions. In most of the activities, students in one group were sitting face-to-face together. However, in the group activities that being analyzed in this paper, students in the same group sat apart so that they were not able to talk verbally but could only utilize GS to communicate with each other. The purpose of this design is to find out the role of GS and interaction moves via GS by restricting face-to-face interactions. The conditions of this design serve as a boundary condition for mediating through the GS representation, and we believe that the analysis of the boundary cases can inform the more normal practice of student collaboration and mediation through both face-to-face and GS representations. For this paper, we will focus on the boundary cases. We will share two group interaction episodes which involve learning new Chinese words and constructing ideas and words around a picture frame to illuminate how students co-construct knowledge mediated by GS representations for language learning.

In Chinese language lesson on learning new words, the teacher selected 5 new Chinese words that the students were going to learn from one article of the textbook, and asked each of the ten groups in the class to choose one word to discuss and work on as a group. To facilitate students' learning, the teacher designed an organizer template and uploaded it as the background of each GS group board, for each group to collaboratively perform various tasks to learn the words. Figure 2 illustrates the template, in which the new word to be learnt has been given with the Chinese phonetics of the main character shown in the center of the left square. As shown, in this case it is "祈求" (meaning 'impetrate' or 'beseech or beg for'). The space surrounding the square is divided into 6 sections, each of which is dedicated for one task. Starting from the top left in anticlockwise order, the tasks are: 1) to explain the meaning of the word, 2) to give a few homophones of the main character of the word, 3) to give a few similar characters as the main character of the word, 4) to use the main character of the word to another word (word formation), 5) to contribute lexicon associable with the given word, and 6) to form a sentence using the words or concepts related to the words. For task 5, more space is available for the

group to write down words or concepts associated with the word much like creating a concept map. After completing their own group task, the students can switch to other group boards by clicking the group number on their GS screen to see other groups' work and offer comments. The teacher monitored each group work via her computer screen although she seldom intervened so as not to interrupt the students learning within the group and from other groups. At the end of the activity, the teacher would consolidate all the group work by summarizing the strength and weakness of each group work as manifested in their GS artifacts, and would devote more time discussing common language weakness and errors with the students.
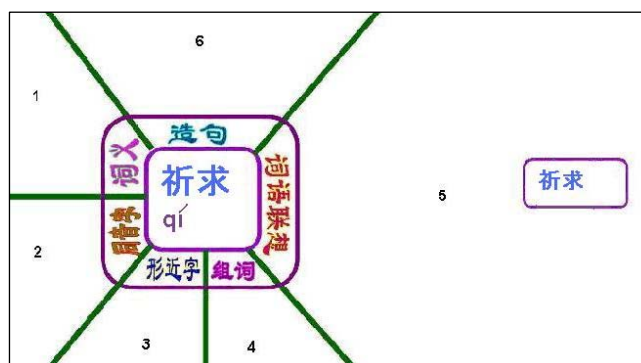

Figure 2. Template for Chinese words learning activity

The purpose of this activity is to enhance students' awareness of the character components, make them familiar with the usage of the words via making sentence, and through the interactive activity arouse students learning interest. In particular, the section on word association stimulates students who might have different vocabulary competencies to collectively co-construct, enriching their vocabulary and imagination, as well as promoting their understanding of the contexts in which the word can be used.

In another type of Chinese picture writing lesson, the students are shown a sequence of 6 picture frames, the first 5 have pictures, and the last one is blank. The 5 frames show in a comics-like way a story fragment. The 6th frame is left blank so that the students can imagine different endings to the story. Different groups are assigned to different picture frames. They are asked to think of fragments of a story line to fit the picture, and towards that, to think of associated words, concepts and ideas much like what concept mapping is. Working as a group, the students use GS to pool together their ideas to spin a good story. In guiding them, the teacher asks the students to think of an explicit storyline and to contribute as many good words as they can to describe the given picture, rather than post a complete paragraph.

The purpose of this activity design is to stimulate the students' thoughts and imaginations through interacting with each other, and to assist them to organize their final compositions well and enrich the content. They work as a group to compose the "concept map" for a picture frame in the class, and at a later lesson, each student will write their own composition based on the group-composed storyline and words to string all the 6 picture frames together. In the GS activity, while each student in the group can brainstorm, and write and post GS notes to express ideas, as there is one storyline for the group, there needs to be some coherence in the ideas which emerge when the words in the GS notes are stringed or put together. Therein lies a need for students to negotiate the storyline amongst themselves when they see potential contradictions or challenges to putting different ideas together.

Interactional Moves

In this paper, we attempt to investigate the group collaborative learning when the students were jointly doing the task in both learning new words and writing composition by sharing the interactions in the group and identifying the interactional moves.

We look at the first target group, namely Roger's group, which comprised of two moderate ability students— Roger and Sharon, and two poor ability students — John and Tina. Roger is the leader of this group. There are no high ability students in this group, but they are seen to be able to work together in harmony and their group's work is typically well-organized.

Figure 3 shows a segment of interaction of Roger's group when they were jointly complete the task about learning the word "祈求". The interactions presented are two episodes about how group members help Sharon to complete the words association occurred at the beginning and the end of the activity respectively. At the beginning of the interaction, Roger was distributing work to different members via GS as they were not able to talk to each other when seating apart. Roger posted "Sharon, ok?" in the section of word association to see if

she is comfortable in doing the task (see Figure 3, R1). Sharon saw Roger's posting and replied "ok" (see Figure 3, S2) to confirm she would like to take the sub-task.

As Sharon got struck on the word association task, she posted a note to ask peers' help (see Figure 3, S3). Roger saw her posting in time and responded her with a constructive phrase "祈求上帝" (meaning 'appeal for the god') immediately (see Figure 3, R3-R4). Taking Roger's idea, Sharon re-wrote the word "上帝" by herself and posted it. Then inspired by Roger's given word, she posted another word "神明" (meaning 'the deities') which has the similar meaning of "上帝" to collocate the center word "祈求". Hence, she could continue building the words map smoothly (see Figure 3, S5-S7).

In the next segment of analysis, we come to the point when Sharon almost finished her task. Sharon posted GS note "still can think what?" for seeking peers' co-contribution (see Figure 3, S8). The weak student Tina is the first member who saw her posting, but she did not give a response to Sharon (see Figure 3, T1-T2). A few minutes later, Roger captured Sharon's note and gave her a proposal showing "hao de dong xi (Hanyu Pinyin or Chinese phonetics)" which means good stuff (see Figure 3, R5). In case his peers could not understand, he reposted it in English again (see Figure 3, R6). But it seems that he was still worried, so he wrote down "平安" (meaning 'safety') referring to "good stuff". Concurrently the other member John clicked Roger's posting "hao de dong xi" reading it. Following Roger's proposal "hao de dong xi"/"good stuff", John contributed "糖果" (meaning 'candy'), which belongs to the good things in his opinion (see Figure 3, J1). As the time was up, although Sharon had read her peers' postings, she had no time to contribute further.

From our analysis of this activity, we identify these interactional moves:

- Ask for help explicitly using a GS note (See Figure 3, S3, R3 and S8, R5-R7): This happened in a situation when a student needs ideas from the other group members to start or continue his/her work. In GS classes where the students in a group are seated together, we observe that students will ask for help verbally and their group members may pause or stop what they are doing, and respond with some help. In the case of students seated apart, they will appropriate the technology to collaborate - they sought help by using the technology, in which inscriptions are not just about the content of collaboration, but about help-seeking and coordination of the collaboration. In response to Sharon's request for help for more ideas or notes in S7, Roger responded with R5 and R6 which suggest what should be talked about, namely good stuff to impetrate, an idea, before posting an actual content contribution in R7. This interactional move seems to be a generic one in the sense we can expect such requests for help to also happen in GS lessons in other subjects like mathematics and science.
- Apart from the role of "interaction device", Chinese character representation plays an important role on Chinese Language learning due to its logographic nature. Imitate by re-writing the contribution of others, and refining it (see Figure 3, R4, S5): This practice is very much related to language learning.
- Write new words with similar meanings when cued by contributions of others (see Figure 3, R4, S7 and J1): This practice is also related to language learning.

From this short episode, we note that the uptakes comprise agreement, agreement with improvisation, and dependent relationships; there is no uptake that is interpreted as disagreement and incomprehension.

Now, we look at another episode in collaborative brainstorming and writing (see Figure 4). In the interactional moves of this group, there is no explicit request for help, and yet there is productive interaction between the students. We will look at an interaction segment which occurred between Henry and Lois (see Figure 5). This group chose picture 5 for brainstorming the storyline and the words or phrases they can use in writing up the story. The picture shows two boys in roller skates shouting and chasing after a boy who wore a cap. One might imagine a storyline in which the boy with the cap is a thief, and he is caught in the act, and hence the chase. Indeed this is what this group picked up. The episode starts when Lois posted a GS note that says "溜滑轮" (meaning 'roller skates') and "速度很快" (meaning 'high speed') to unfold the plot of the story (see Figure 4, L1). Henry followed her note by providing a posting that says "追上了小偷" (meaning 'caught up the thief') (see Figure 4, H1).

However, it seems that Lois was not quite satisfied with using Henry's posting as the next connection. Thus, she shifted it aside and put her own note that says "使主人速度比较快" (meaning 'make the speed of the owner faster') in between her posting "速度很快" and Henry's posting "追上了小偷" (see Figure 4, L2). Seeing Lois's new note, Henry posted a note with the question "谁是主人？" （meaning 'so who is the owner?'） referring to Lois's posting (see Figure 4, H2). Then Lois used the concrete names "小明和小华"

(two Chinese names) instead of "主人" (meaning 'the owner') which may cause confusion (see Figure 4, L4). Henry further asked Lois "怎样的速度" (meaning 'what is the speed'), and he offered her the Chinese words for "奔跑" (meaning 'gallop') as a suggestion (see Figure 4, H3-H4).
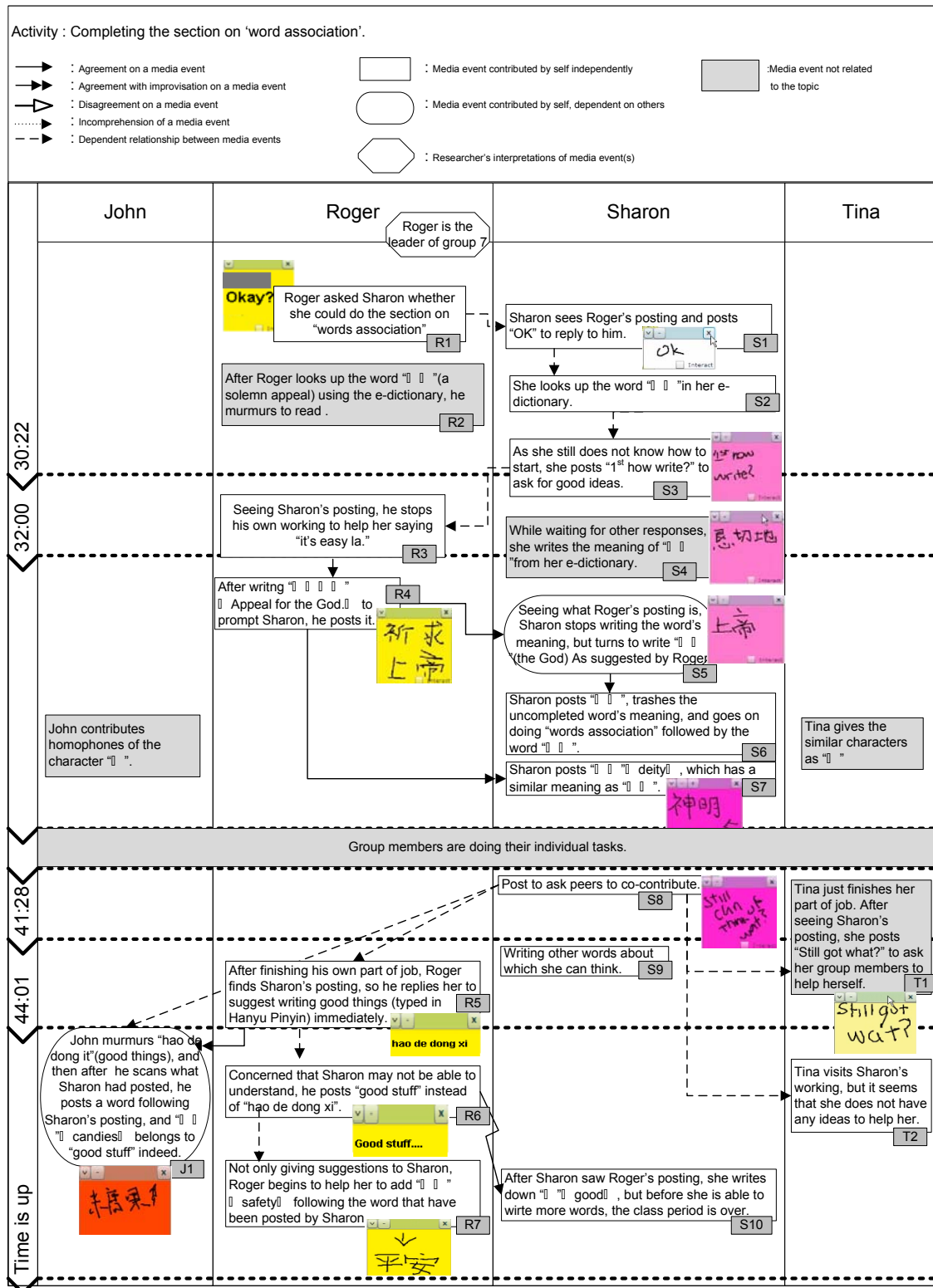
Note: *As students communicated bilingually, when their postings were in Chinese, English translations/meanings were provided between parentheses. But if their original postings were in English, we transcribed them verbatim including typing and grammatical errors.*

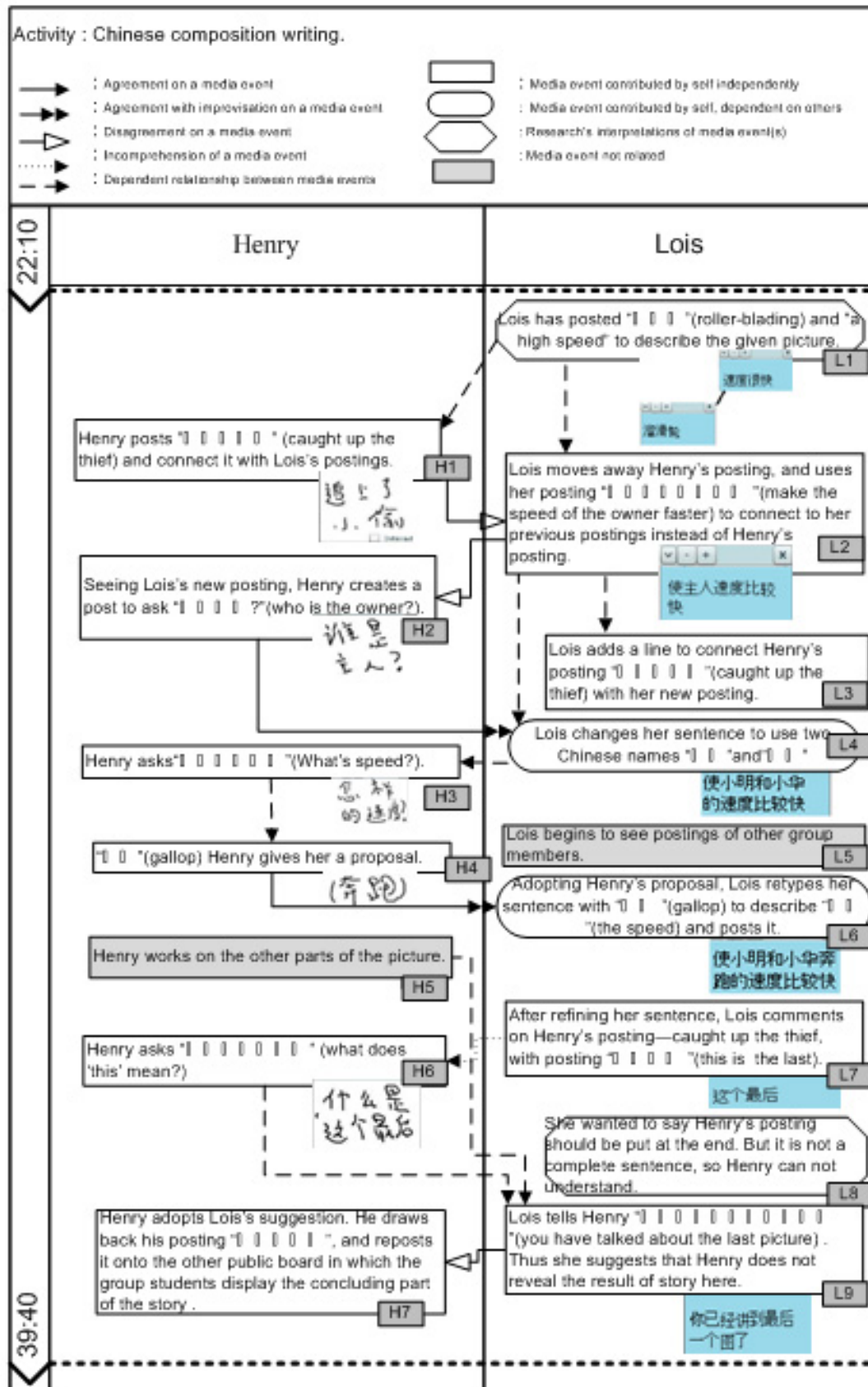Figure 3. Intra-group interaction with explicit requests for help

Figure 4. Intra-group interactions with peers building on each other contributions

Lois adopted it and refined her sentence again (see Figure 4, L6). Besides adopting Henry's suggestion, she made a suggestion to Henry by posting a note that says "this (should be put) at the end (of the idea sequence)" (see Figure 4, L7). In Lois's opinion, '追上了小偷' should be put the description for the concluding frame or picture 6 of the story, so as to create more suspense by putting it at the end of the story. Since Lois did not express it completely, Henry did not quite understand it. Hence, Henry asked Lois what "this" refers to (see Figure 4, H6). After receiving Lois's further explanation, he responded by moving his posting to another position (see Figure 4, H7). Figure 5 shows the final artifact of their co-constructed representations.

We identify the following interactional moves:
- See what is shared or what is newly posted, and recommends new ideas/words (H1)
- See what is on a note, and asks clarifying questions (H2)
- Seek clarification on ambiguous or unclear instructions (H6)
- Help peers polish a sentence (important for language learning) (H3-H4)
- Refining her sentence according to Henry's suggestion, Lois not only imitates but also assimilates new information (L6).
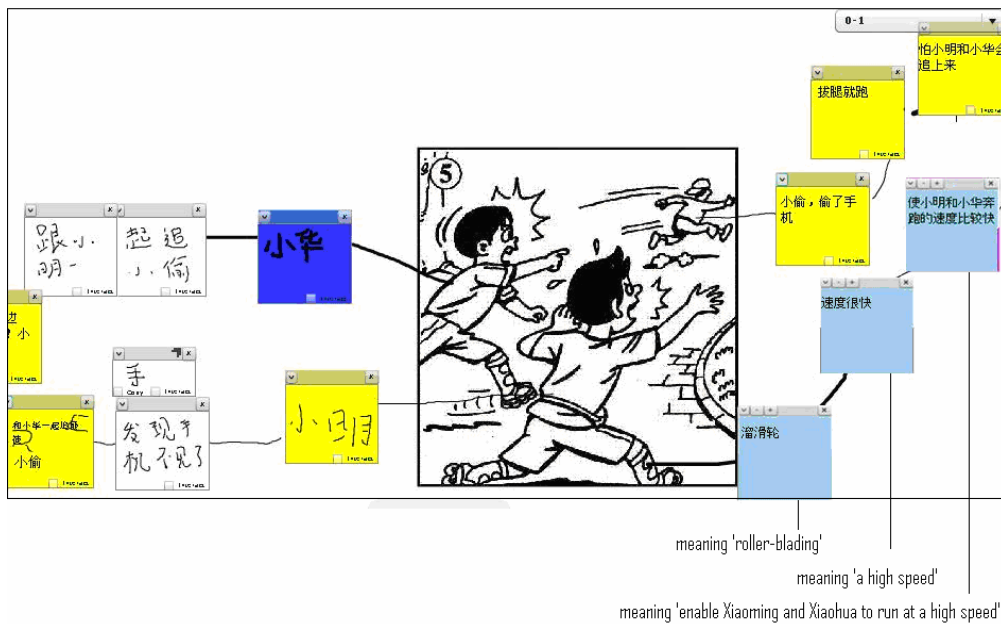

Figure 5. Parts of screenshot of the public board about Henry's group

The first three are clearly generic moves that we expect to see in GS lessons in mathematics and science, while the last two are more specific for language learning. From the perspective of second language learning, the identified practices documented that students had actually engaged in modified interactions by requesting and receiving the modified input, such as written text (Chapelle, 1998). Theory and research have suggested that the saliency of the target language input (Doughty, 1991; Sharwood, 1991) and opportunities for production of comprehensible output (Swain, 1985, 1998; Swain & Lapkin, 1995) are important for language acquisition.

This short episode has more uptakes that are interpreted as disagreement. By involving students collaborating to build up a story, it lends itself to more crashes of ideas, more contention and disagreements and more counterproposals. In the first episode, the activity is about fleshing out the different aspects of the selected words, and it lends itself to more associational idea generation.

Discussion

In both episodes, the GS environment is used in generating and sharing new ideas and knowledge related to vocabulary mastery and picture composition. The first episode happens when a student requires ideas from the other group members to start or continue his/her work. The practice has this pattern of "asking clarifying questions": Asking for help on his/her initiative, leading to imitation by re-writing from observing a response to the help, and then completing the task cued by contributions of the other members. The second episode happens when the student has represented some of his/her ideas through GS representations which become available for others to view and respond to. The practice has this pattern of "sharing your ideas and letting the others critique or build on these ideas": Peer group members on their own initiative offer help, then imitation by re-writing, and improvement or completion of the artifacts cued by contributions of others.

In the Chinese language learning context, it can be seen that no matter when help, feedback or critique is provided by group members, "imitation by re-writing" is one of the practices which seems common in language learning in these episodes. Through reading/observing the written representation from others, imitators are able to extract useful information, and refine own postings. This practice plays an important role in language learning and is the key part of the whole process of representational practices. Imitation is never a strange concept in language study. Imitation plays a role in the language acquisition process (Speidel & Nelson, 1989). Vygotsky (1930/1978, 1934/1986) noticed that children start to use new adult words before they fully understand the meaning of the words, and they learn the meaning by using the words. They begin to individualize peer or group knowledge through imitation. For L2 learning, imitation is a process of cognitive actions involving words, phrases, clauses, and sentences, which can happen in every phase of language learning. In mathematics learning, we see students imitating other group members' routines and gradually individualizing them as their own abilities.

In addition, the interactional moves are enabled by the affordances of the GS, in particular, the lightweight characteristic of GS. In web-based discussion forums or collaboration, succinct contributions shorten the response interval and avoid the phenomenon of 'interlaced communication'. In Liu and Burn's (2007) study of how to improve virtual team performance, they illustrated 'interlaced communication' as the situation in which responses are made in an interval of two or more than two postings instead of responses to the most recent posting. They asserted in this situation, a discussion topic was often terminated inexplicably instead of fully discussed. However, in GS environment, the interactional moves would not be affected adversely by 'interlaced communication'. The lightweight characteristic of GS plays the role of focusing the students' attention on the topic under discussion. In common web-based communication, there is a problem of information overload. Discussants can be so overwhelmed with messages that they ignore what others write and the conversation devolves into monologues (Moran, 1991). In the GS environment, they need not devote too much time and energy on overwriting and reading the postings of others. Moreover, it is unrealistic for primary school students learning a L2 (Chinese in this case) to do 'heavyweight' writing in classroom activities. When students attempt interpretation by writing down their responses, they can capture those insights and perceived connections so that those can be returned to, critically examined, reconsidered, and perhaps made the basis for the construction of a further sustained text of one's own (Warschauer, 1997).

Conclusion

Building on Stahl's notion of group cognition (2006) and Suthers' notion of uptakes (Suthers, et al., 2007), we propose five types of uptake responses in creating a representation and an interpretation of the transcripts in which groups of four students collaborate over the GS medium. Our analysis above shows an explanation of how two groups negotiated meaning-making in different ways. One group converged on a shared understanding of words learning and development of a storyline with accompanying articulation of the words, phrases and sentences used. One group displays explicit requests for peer responses while another group shows knowledge building on a shared workspace. This work is an initial exploration of negotiated interactional moves in the context of L2 learning in a GS environment. Future research plans include: examining their practices in a F2F situation; analyzing practices of groups across time, that is, across several sessions to study interactional moves as practiced by the group and how they evolved over time; distilling more stable patterns of interactional moves across groups and across time.

References

Chapelle, C. A., (1998) Analysis of interaction sequences in computer-assisted language learning. *Tesol Quarterly*, 32 (4), 753-757

Chen, H. Y., & Liu, K. Y., (2008). Web-based synchronized multimedia lecture system design for teaching/learning Chinese as second language. *Computers & Education*, 50, 693-702.

Doughty, C. (1991). Second language instruction does make a difference: Evidence from an empirical study of SL relativization. *Studies in Second Language Acquisition, 13,* 431–469.

Enyedy, N. (2005). Inventing mapping: Creating cultural forms to solve collective problems. *Cognition and Instruction*, 23(4), 427-466.

Kozma, R. B., & Russell, J. (2005). Students becoming chemists: developing representational competence. In J. Gilbert (Ed.), *Visualization in Science Education*. London: Kluwer.

Liu, Y.C. & Burn, J. M. (2007). Improving the performance of online learning teams – a discourse analysis. *Journal of Information Systems Education*, 18.

Looi, C.K., Chen, W. L., Tan, S., Wen, Y., & Wee, J. D. (2008). Towards analysis of group interaction process mediated by rapid collaborative learning environment. Proceedings of the *16th International Conference on Computers in Education*, Taipei.

Medina, R., Suthers, D., & Vatrapu, R. (2009). "I have an interesting way of looking at this problem": representational practices in VMT, to appear in Stahl, *2009 "Studying Virtual Math Teams" Springer's CSCL series*.

Moran, C. (1991). We write, but do we read?. *Computers and Composition*, 8, 51-61.

Ministry of Education. (2004). Report of the Chinese Language Curriculum and Pedagogy Review Committee. *Singapore*. http://www.moe.gov.sg/press/2004/ CLCPRC%20Committee%20Report.pdf.

Ng, F. K. Looi, C.K., & Chen, W. L. (2008). Rapid collaborative knowledge building: lessons learned from two primary science classrooms. *In - (Ed.) International Conference on the Learning Sciences, Utrecht* (pp. 8). Utrecht: ISLS.

Roth, W. M. (2003). *Towards an Anthropology of Graphing: Semiotic and Activity-Theoretic Perspectives*. The Netherlands: Kluwer Academic Publishers.

Sharwood, S. M. (1991). Speaking to many minds. *Second Language Research, 7,*118–132.

Shen, H. H. (2004). Level of Cognitive Processing: Effects on character learning among non-native learner of Chinese as a foreign language. *Language and Education*, 18(2), 167-184.

Speidel, G.E., & Nelson, K. E. (1989). *The many faces of imitation in language learning*. Springer-Verlag New York Inc.

Stahl, G. (2006). Sustaining group cognition in a math chat environment. Research and Practice in Technology Enhanced Learning (RPTEL), 1 (2).

Stahl, G. (ed.). (2009). *Studying virtual math teams*. New York, NY: Springer. Computer-supported collaborative learning book series, vol. 11. Available at http://GerryStahl.net/vmt/book.

Zemel, A., Çakir, M. P., & Stahl, G. (2009Suthers, 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.

Swain, M. (1985). Communicative competence: Some roles of comprehensible input and comprehensible output in its development. In S. M. Gass & C. G. Madden (Eds.), *Input in second language acquisition* (pp. 235–253). Rowley, MA: Newbury House.

Swain, M. (1998). Focus on form through conscious reflection. In C. Doughty & J.Ê Williams (Eds.) *Focus on form in classroom second language acquisition* (pp. 64–81). Cambridge: Cambridge University Press.

Swain, M., & Lapkin, S. (1995). Problems in output and the cognitive processes they generate: A step towards second language learning. *Applied Linguistics, 16,* 371– 391.

Tse, S. K. (Ed) (2001). *Effective learning of Chinese characters*. Hong Kong: Greenfield Educational Centre [in Chinese].

Tse, S. K. (2002). *Comprehension and effective learning of Chinese characters*. HongKong: Greenfield Educational Centre [in Chinese].

Vygotsky, L. (1987). *Thinking and Speech*. New York: Plenum

Wang, Y., Liu, Z. J., Liang, S. T., & Wang, S. Q. (2007). The effects of on-line peer assessment upon sixth grade students' thinking processes of writing, *The Global Chinese Conference on Computers in Education (GCCCE) Conference 2007*. Guang Dong: HNU [in Chinese].

Warschauser, M. (1997). Computer-mediated collaborative learning: theory and practice. *The Modern Language Journal, 81*(4), 470-481.

Wing, W. K., Ho, C. L., Chung, A. L. S., & Tse, S. K. (2003). Structural awareness, variation theory and ICT support. *Educational Studies in Language and literature, 3*, 53-78.

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