

The appropriation of a representational tool in the second language classroom

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Abstract: This case study investigates the appropriation of a representational tool by students in small groups in the context of collaborative second language writing. The functions of inscriptional devices in second language classroom learning are identified: (1) referencing, (2) pinpointing, (3) accumulating, (4) prompting notice, (5) realizing parallels, and (6) promoting synergy. The study explores the beneficial affordances of the representational tool that supplement face-to-face communication for second language learning, and draws some implications for the design of collaborative L2 learning in networked classrooms.

Keywords: Representational tool, Networked Classroom learning, CSCL, Computer-supported language learning

1. Introduction

Computer-supported language learning has received attention since computers have been used for word processing, and has developed rapidly with the availability of online technologies. The use of computer-supported collaborative learning is more and more commonplace in language learning classrooms (Dooly, 2011). Technical artifacts can augment spoken and gestural communication between copresent collaborators (Roschelle, 1994; Suthers, Girardeau, & Hundhausen, 2003), and they can be embedded in classrooms where face-to-face communication is still a main channel for interaction (Lingnau, Hoppe, & Mannhaupt, 2003).

In recent years, a kind of generic representational tool—Group Scribbles (GS), which consists of a graphical shared workspace—has been codeveloped for enabling collaborative generation, collection, and aggregation of ideas through a shared space based on individual efforts and social sharing of notes in graphical/textual forms (for more information, see SRI International, <http://groupscribbles.sri.com/>). The educational benefits of representational tools have been recognized, such as when selecting relevant information, organizing information into coherent formats, or relating it to prior understanding (e.g., Liu, 2011; Stull & Mayer, 2007). Yet most of the studies focus on reporting the positive or negative effects of them on the students' learning performance or learning motivations (Hwang et al., 2014) or accentuate how to design or script a representational tool in online learning. Less attention (Overdijk & van Diggelen, 2008, as an exception) is paid to how groups of learners appropriate a representational tool in a classroom environment in which face-to-face communication is an integral part of the learning interactions, and to how technical artifacts mediate face-to-face communication.

Situated in a Chinese as second language (L2) learning classroom setting equipped with GS, the study aims to explore the beneficial affordances of the representational tool that supplement face-to-face communication for *group understanding development* (in this study, it is an operational definition of group's collective thinking for judging group performance, including both mutually and partially shared meaning) in L2 learning classrooms, and thus provides insights to task/script design and enactment of collaborative L2 learning in networked classroom environments where face-to-face and online interactions are intertwined.

2. Literature Review

2.1 Use of representational tools

Prior research on CSCL has highlighted the importance of representational aids, such as dynamic notations, knowledge maps, and simulation for collaborative learning performance (Fischer et al., 2002; Janssen et al., 2008; Slob et al., 2010; Wegerif et al., 2010). Embedding representational tools in a CSCL environment can facilitate students' construction of multimodal representations of the domain knowledge and thereby guide their interactions (Slob et al., 2010). Through representing ideas and understandings on the shared work space, students' thinking is made public and exposed to critical scrutiny, during which cognitive development can occur (Liu & Kao, 2007). Suthers and Hundhausen (2003) have concluded that external representations play at least three roles that are unique to situations in which a group is constructing and manipulating shared representations as part of a cognitive activity. They are: (1) initiating negotiation of meaning; (2) serving as representational proxy for purposes of gestural deixis (reference to an entity relative to the context of discourse by pointing) rather than verbal descriptions; and (3) providing a foundation for implicitly shared awareness. Although the educational benefits of representational tools are widely recognized, some studies report mixed or even negative findings and thus question how students' interaction can best be guided (e.g., Bera & Liu, 2006; Elen & Clarebout, 2007).

In accordance with other computer-mediated communication tools used in education, the presence of a representational tool in the classroom alone does not automatically benefit students' learning (Slob et al., 2010). A given tool offers affordances that may influence how learners engage in knowledge construction (Kozma, 2003; Suthers & Hundhausen, 2003) but do not causally determine their learning outcomes (Hakkarainen, 2009; Medina & Suthers, 2012). Technology does not determine the nature of its implementation but coevolves with gradually transforming instructional practices (Tuomi, 2002). Learners can appropriate the multimodal resources for their own purposes, and this appropriation (as well as the influence of the technology) can develop over time (Medina & Suthers, 2012). Even though there are stable characteristics of tools that are generalizable over different settings, the tools can be appropriated in unexpected ways (Dwyer & Suthers, 2006; Overdijk & van Diggelen, 2008). Different groups evolve alternative approaches to representational practices with the affordances of representational tools (Larsson & Alterman, 2007). It is like what Carrol et al. (2002) pointed out that appropriation can be seen to be a process which combines technological determinism (that affords and constrains certain activities and partly determines the boundaries around the activities that are possible) with social shaping within these boundaries. Only when collaborative technologies (including representational tools) have been fully fused with social practices of teachers and students, are their intellectual resources genuinely augmented and learning achievements correspondingly facilitated (Hakkarainen, 2009). Therefore, this study focuses on analyzing how the GS representational tool was brought into use in a good lesson.

2.2 Analytic frameworks for investigating interaction in CSCL

During the past decade, analytic frameworks and approaches for analyzing interaction in CSCL have been getting increasingly sophisticated. It is posited that the methodological uniqueness of CSCL research "is reflected in the several approaches that have been put forth to document and analyze collaborative interactions" (Puntambekar et al., 2011, p. ix). These frameworks/techniques are used for examining interactions in different representational formats (e.g., forum-based or mapping-based) and with different analytic foci and assumptions about what it means for participants to achieve a conceptually deeper level of interaction.

As whether only the temporal issue (or the chronological dimension) is taken into account, they can be classified into two major categories: (1) the nature of the function of participants' contributions in the dialogue and (2) patterns and trajectories of participant interaction. Besides, the bulk of the analytical frameworks/techniques are applied to examine interaction happening in a single dialogue-based interaction environment, and only a few revolve around interaction happening in dual-interaction spaces (e.g., Hmelo-Silver et al., 2011; Suthers & Rosen, 2011). Furthermore, none of them is specific for analyzing interaction in language learning. In the study reported here, open coding is adopted.

3. Methods

This case study was derived from a 5-year project that integrates GS in language learning for sustaining collaborative activities in language learning classrooms. The “ideal” case lesson was the last GS lesson of a semester. This lesson was selected in terms of the reflection from the teacher and students. As the teacher mentioned her post-lesson interview “today’s lesson is completed smoothly as we planned...”

3.1 Participants

The subjects of this study were from a class of a secondary school (Grade 8). The class consists of 6 female students and 13 male students (aged from 14-16). In every GS lesson, these 19 students were separated into five groups based on their previous school examination scores for the Chinese language subject. A comparative high-ability group, a medium-ability group, a comparative low-ability group, and two mixed-ability groups were formed. In order to build and sustain the group culture, the group compositions remained unchanged from the beginning stage till the end of the implementation of this study. The last GS lesson was selected on the assumption that the teacher and students had developed familiarity with GS-based collaborative activities.

3.2 Learning environment and the activity design

Figure 1 shows the GS classroom environment where 3-4 students sitting in groups, and each of them had their own laptop to access and use the GS tool. An Interactive Whiteboard was set up in front of the classroom to help the teacher to visualize and monitor the interaction processes of every single group.



Figure 1. GS classroom environment

The lessons were about collaborative L2 writing. The main learning objective of the lesson reported in this paper was to help students understand that an argumentative essay can be conceptualized and composed from exploring the contributing factors of a phenomenon, followed by finding its impacts and providing solutions if needed. In the GS tool, a template (Figure 2) was uploaded as the background in order to provide tangible scaffoldings for students to follow the teacher’s instruction (Wen, Chen & Looi, 2011) and to allow them to pay attention to the three elements (cause, consequence, and solution) necessary in writing an argumentative essay.

整容现象产生的原因:	这一现象导致的后果:	解决方法:
Causes	Consequences	Solutions

Figure 2. A graphic organizer for the planning task

3.3 Data collection and analysis

The main data sources for this study were the video data of the face-to-face and GS-based interactions in the various groups. In addition to video cameras, the iShowU screen-capturing was installed on every student's MacBook to record all the actions of individual students on the computers, as well as their verbal talks and facial expressions.

For the data analysis, all the video data were first transcribed verbatim, synchronized and presented chronologically. Then all the interaction data were coded on the multiple levels with different dimensions. At the macro-level, the interaction data were coded back and forth with two dimensions: the medium and functions of interactions using the unit of "event". "Event" in this study referred to a series of uninterrupted interaction moves with the same semantic content that happened through the same medium. It could be a two minutes long conversation as long as the participants were talking about the same topic unceasingly. It also could be as short as one verbal sentence or a single GS posting.

This study aims to investigate students' interactions across face-to-face and online interactional spaces. Student's interactions in the unit of event were categorized into face-to-face-based and GS-based in terms of medium, and then these events were further categorized in terms of the *function* performed to complete the task: whether it is social-related or cognitive-related. Additionally, as the study is focused on exploring the trajectories of group understanding development, any events regarding off-task issues, such as technical problems, jokes, greetings etc., would not be included in the data analysis of this study. In view of these, all the events were classified into three categories related to functions performed to complete the task: cognitive-related, social-related, and off-task. In the study, the "social-related" category termed as "Regulation", refers to interactions about regulating and coordinating group work. Taking account of the characteristics of L2 learning, the "cognitive-related" interactions were further categorized into two sub-categories: Content-related and Language-related. These categories were established as the result of a repeated process of iterating back and forth between theory and data (Onrubia & Engel, 2012).

Diagram Representation		Content	Participants	Note & Interpretation
GS	Face-to-face			
		<ul style="list-style-type: none"> ➤ T: 这边呢? 分类怎么样了? [How about here? How about your classification?] ➤ William: 我们用那个“五指山”来分类。 [We classified based on "Five fingers".] ➤ T: 对, 五指山。对, 所以呢? [Yes, "Five fingers". All right, then?] ➤ William: 我们有对自己不满, 比如说对自己不满, 嗯, 还有家庭的原因。 [We have "not satisfied with own appearances". Eh, also have reasons from the family perspective.] ➤ T: 家庭会有什么原因啊? 什么原因会是家庭的? [What kind of reasons from the family perspective? What kind of reasons belongs to the family's] ➤ William: 嗯... [Eh...] ➤ Sophia: 家庭也可以是兄弟姐妹的事。 [It could be about brothers or sisters.] ➤ T: 对, 可以写兄弟姐妹的影响。 [Yes, can write something effects from brothers and sisters.] 	Teacher, William, and Sophia	<ul style="list-style-type: none"> ❖ When Group 3 was on the point of re-organizing their existing postings, the teacher intervened and asked the students about their work progress. ❖ William responded to the teacher that they had contributed some ideas from "the personal perspective", but it is worth noting that "reasons from the family perspective" never occur in this group's previous discussion. It seems that this a new idea that has popped up in William's own mind.
		<ul style="list-style-type: none"> ➤ Sophia: 我来, 我写。 [I do it, I write it] 	Sophia	
		<p>[Because people (friends or families) like to compare him with his brothers and sisters. E.g., saying the elder brother is more handsome than the younger.]</p> <p>因为人(朋友/家庭)一直把他跟兄弟姐妹一起比。比如: 说哥哥比弟弟帅。</p>	Sophia	

Legend:

3G1 refers to group 3's first GS posting (the small rectangle in broken link means the posting is not newly created).

3G7 refers to group 3's seventh GS posting

3C4 refers to group 3's fourth Content-related verbal conversation

3R4 refers to group 3's fourth Regulation-related verbal conversation

Figure 3. Diagram for analyzing across-media interaction at the micro-level

Coding on the macro-level provided an objectively “first pass” about the interaction distribution. Then on the micro-level, the interaction sequences and contextual information were taken into consideration in coding. A kind of diagram was created to visualize the sequence of interaction events and their relations (Figure 3). As shown in the figure, the flow from top to down denotes the time sequence. GS postings and verbal conversations are presented in two separated columns. Their content is shown in the central big column. The information regarding participants, media and functions of interactions could be obtained from the diagram directly. Two other concepts were proposed to help identify the medium transition (interactions happened across different media). One is “*cross-media adjacency events*”. These are represented in solid lines with arrow, to signify the adjacent cognitive meaningful events spanning different medium spaces. The other is “*cross-media responses*” which indicate that those cross-media interactional moves happened between GS postings and social-related/off-task events (represented in broken lines). They are represented by dotted in the diagram. In this study, we focused mainly on “cross-media adjacency events”.

In sum, this is a pre-dominantly qualitative case study. Quantitative information about interaction distribution in different small groups is mainly provided to help select and interpret the interesting excerpts for micro-level analysis.

4. Findings

4.1 Interactions with various content via different media

Table 1 shows the medium distribution of the interactions in different groups. In addition, the results noted that task management-related communication or coordination, and even off-task interactions, did not occur in the GS environment. That meant the GS environment mainly served as a shared external memory where the group kept a record of shared understandings. Face-to-face interactional event, however, could be classified into different categories of function (see Table 2).

Table 1: Description of group interactions in different media spaces

Group \ Medium	Homogeneously high-ability group	Heterogeneously high-ability group	Homogeneously middle-ability group	Heterogeneously middle-ability group	Homogeneously low-ability group	Total
No. of face-to-face interactional events	102 (25.95%)	95 (24.17%)	72 (18.32%)	71 (18.07%)	53 (13.49%)	393 (100%)
No. of GS postings	51 (34.23%)	21 (14.09%)	18 (12.08%)	31 (20.81%)	28 (18.79%)	149 (100%)

Table 2: The distribution of face-to-face interactional events in different groups (N =393)

Group \ Function	Homogeneously high-ability group	Heterogeneously high-ability group	Homogeneously middle-ability group	Heterogeneously middle-ability group	Homogeneously low-ability group	Mean (SD)
Content-related	48 (47.1%)	38 (40.0%)	27 (37.5%)	27 (38.9%)	27 (50.9%)	33 (9.628)
Language-related	3 (2.9%)	5 (5.3%)	11 (15.3%)	9 (12.7%)	6 (11.3%)	7 (3.535)
Regulation	39 (38%)	45 (47%)	26 (36%)	31 (44%)	16 (30%)	15 (8.031)
Off-task	12 (11.8%)	7 (7.4%)	8 (11.1%)	4 (5.6%)	4 (7.5%)	7 (3.317)
Total	102 (100%)	95 (100%)	72 (100%)	71 (100%)	53 (100%)	78 (19.83)

The quantitative data suggested that all the groups actively participated in completing the task (mean of Off-task =7, $SD = 3.317$). The empirical data showed that group language competency influenced the way in which the representational tool was appropriated. The results indicated that group language proficiency restricted L2 learners’ involvement in verbal talk, especially when they were encouraged to communicate in the target language. Yet its influence on their involvement in online interaction was not so compelling (shown in Table 2). Groups with higher language proficiency tended to focus more on content-related knowledge talk than on language-related knowledge talk (shown in Table 2).

4.2 Interplay between medium transition and group understanding development

Zooming in on the co-construction process of group inscriptions, the analysis of both cross-media adjacency events and cross-media responses helps to identify the semantic and temporal relationship among face-to-face and GS-mediated interactions and to understand the kind of situations in which group understanding development occurred more effectively. Beyond the understanding that the representational tool served as an external shared space where small groups kept a record of shared thinking (Suthers & Hundhausen, 2003), the role of inscriptional devices in group understanding development was further identified and demonstrated through the qualitative microanalysis of the interactions. In this sense, the findings revealed the fabrics of common ground in a classroom environment with representational tools. Table 3 shows a summary of the patterns of medium transition, their corresponding trajectories of group understanding development, and the role of inscriptional devices functioned.

Table 3: the summary of findings

Pattern of medium transition	Trajectories of group understanding development	The role of inscriptional devices
GS→CONT	<ul style="list-style-type: none"> Provide comments towards the existing posting but without changing its content. 	Referencing
GS→LANG	<ul style="list-style-type: none"> Inquire about the pronunciation or meaning of specific characters/phrases relevant to the posting. 	Pinpointing
GS→ CONT (LANG) →GS	<ul style="list-style-type: none"> Read out the written content of an inscription. Promote verbal discussion by pointing out the improper content in the inscription or the content that could be better written, or providing a new idea relevant to the inscription. Pool knowledge to polish the sentence/idea, and reach a consensus. Language-related problems may emerge in content-related discussion, and they can be solved implicitly or explicitly. Complete/repeat the sentence verbally. Type out the sentence without any change in GS. 	Promoting synergy
CONT (LANG) → GS	<ul style="list-style-type: none"> Attempt to start a topic with fragmented words or phrases. Assemble or link words/phrases into a complete sentence without explanations. (Language-related problems may be proposed and solved in this process as byproducts). Type out the sentence verbatim in GS. 	Accumulating
CONT (LANG) → GS	<ul style="list-style-type: none"> Verbalize individual ideas. Help one another to express ideas clearly and precisely, involving questioning, interpreting, exemplifying etc. Organize and summarize the ideas that have been co-constructed in verbal form. Translate the summarized ideas into text concurrently. 	Realizing parallels
LANG → GS	<ul style="list-style-type: none"> Ask for help explicitly to complete the text, when a student needs to express an idea to start or continue his/her work. Collect informative linguistic knowledge to translate content, and reach a consensus once a “correct” answer is given. During this process, students are able to clarify the ideas that they would like to externalize and their understanding on the ideas from others. Transform the idea into an inscription. 	Prompting notice

According to the empirical data gained, when the inscriptional device functioned as *referencing*, *pinpointing*, or *accumulating*, the corresponding interactional moves were comparatively less cognitively demanding. Contrarily, when the role of inscriptional devices functioned as *promoting synergy*, *realizing parallels*, or *prompting notice*, the corresponding interactional moves were more cognitively demanding and more productive group interactions occurred, because students engaged in

searching information, explaining, elaborating, and summarizing. It has been widely reported in educational literature that such kind of cognitive engagement requiring higher-order-thinking skills is critical to meaningful learning (e.g., Zhu, 2006). Nevertheless, as observed, this is not always the case that groups with higher language proficiency more frequently draw upon the inscriptional device as *promoting synergy*, *realizing parallels*, or *prompting notice* in group understanding development.

The quantitative data above indicated that group language proficiency influenced the occurrence frequency of language-related talk. Theories of second language learning (e.g., the Noticing Hypothesis from Schmidt, 1990, and the Output Hypothesis from Swain, 1985) have emphasized that the learner's attention to language as an object while engaged in communication is beneficial for L2 learning. Two patterns of medium transition relating to language-related talk and their effects on a small group's L2 development were distinguished. Corresponding to the pattern of medium transition—LANG→GS—the role of inscriptional devices in group understanding development was *prompting notice*. The activity of producing the target language on GS space prompted students to consciously recognize some of their linguistic problems, and this triggered cognitive processes in which group members co-constructed or consolidated their existing linguistic knowledge and created a new posting that was accepted by all of them. Corresponding to the pattern of medium transition—GS→LANG—the inscriptional device functioned as *pinpointing*, which had an emphasis on prompting individuals to inquire about the pronunciation or meaning of specific characters/phrases on the posting. Since no subsequent improvement or creation of a new group inscription can be observed in this pattern, it is difficult to judge whether the mutual understanding is successfully established by all group members. In other words, when the role of inscriptional devices functions as *pinpointing*, group understanding development can be observed but its effectiveness cannot be guaranteed.

The qualitative microanalysis of interaction also revealed that language-related talk often intertwined with content-related talk. Once verbal talk went beyond language-related knowledge, the talk would not be dominated by the authoritative group members, and hence all the members could have comparatively equal opportunities to contribute to their group work. Instead of solely compensating for deficient language-related knowledge, students constantly ventured new ideas and updated their common ground. In such a process, more language-related problems might emerge. Along with this, they effectively constructed and consolidated understanding of both content-related knowledge (including understanding of the given topic and the writing strategy) and language-related knowledge. Nevertheless, it is also worth mentioning that even though corresponding to the same pattern of medium transition, the inscriptional device can function differently. As summarized in Table 3, they can function as accumulating and realizing parallels in the pattern of medium transition—CONT→GS. The data indicated that when the inscriptional device functioned as *accumulating*, the group understanding development seemed less productive. This is because students initially had no clear idea about what they intended to express and they did not seek to find out and fill gaps in their knowledge resources. However, in some cases, students co-constructed ideas from different perspectives through developing an intersubjective orientation toward one another based upon exploratory talk, and then rendered their individual ideas simultaneously. In doing so, productive group understanding development occurred and the role of inscriptional devices was *realizing parallels*. Besides, the role of inscriptional devices as *promoting synergy* in the pattern of medium transition—GS→CONT→GS, which contrasts with its role as accumulating in CONT→GS, put an emphasis on online inscriptions, which are more persistent and may be from other groups, rather than only ephemeral intragroup verbal talk.

The data drawn from cross-media adjacency events also indicated that the role of inscriptional devices was task sensitive. For example, at the first phase of the task, the students were encouraged to provide their own ideas in an initial text. In doing so, the inscriptional device mainly functioned as referencing or pinpointing. At the final phase of the task, however, the students were required to discuss with one another, modify existing inscriptions and create truly shared group inscriptions as products of their collaborations. Even though different small groups still appropriated GS in different ways, the inscriptional device functioned more as promoting synergy, realizing parallels, or prompting notice in more productive group understanding development in all groups. In other words, there was not just one way to utilize the tool to perform the task, and the students were required to make choices.

5. Discussion and Conclusion

Situated in a setting of L2 learning, this study focused on investigating the appropriation of a representational tool in the classroom at the level of the small group. A major concern of this study was to examine how small-group task completion is contingent on cross-media interactions, to explore the temporal scope of this contingency as mediated by persistent inscriptions. The case was selected and investigated when the participants have truly gone through the expansive learning that is required for cultivation of novel computer-mediated collaborative practices of working creatively with knowledge.

The study established a connection between the pattern of medium transition and the trajectory of group understanding development, what was investigated through cross-media adjacency events. The results indicated that using the representational tool—GS in L2 classrooms—is beneficial for collaborative language learning. Empirical data evidenced that different small groups evolved alternative approaches in carrying out the tasks; group language competency, and task design influenced the way in which the representational tool was appropriated. The inscriptional device had significant effects on the students' interactions and had different influences on group understanding development. Stated succinctly, this study provided empirical data to illustrate some of the mutual influences between the tool and the participants.

According to the findings, a number of beneficial features of the representational tool supplementing rather than substituting face-to-face communication within a single language learning class can be summarized. Here we need not elaborate any further on the obvious advantages of online representational effects on enlarging the bandwidth of resource sharing, compared to the traditional use of pen and paper (e.g., the convenience of intergroup interaction without physical movement). The beneficial features of the online representational tool are elaborated by emphasizing its complementary role in the improvement of L2 learning in a classroom environment.

First, *online interaction tends to feature more balanced participation than face-to-face discussion, and online interaction is juxtaposed with face-to-face interaction, and thus students with higher language proficiency are less likely to dominate the group work.* The observation made in this study indicated that all small groups, regardless of their language proficiency, were willing to externalize their ideas or to help improve postings from others, whereas group language proficiency restricted their involvement in verbal talk, especially when asked to communicate in the target language. This result is consistent with the literature on computer-assisted language learning which shows that L2 learners tend to participate more equally and take more risks to experiment with ideas (try more creative ideas) in online environments than in traditional face-to-face classroom environments (e.g., Warschauer, 1999).

Second, *embedding representational tools in classroom learning empowers students to notice their linguistic problems and incorporate knowledge from others to solve problems, and meanwhile the shared space for the co-construction of group output (inscriptions) gives way to discussion about and justifications of representational acts as well as inducing knowledge sharing.* The results indicated that the activity of producing inscriptions in the target language prompted students to consciously identify gaps in their own knowledge, and this triggered cognitive processes in which group members co-constructed or consolidated their existing linguistic knowledge and generated a new posting that was accepted by all of them through verbal discussion (e.g., in the pattern of medium transition LANG→GS, the inscriptional devices function as prompting notice). Therefore, in the context of language learning, the co-construction of inscriptions can be deemed as “writing to learn” (Williams, 2012), which promotes learning content knowledge as well as knowledge about the language (Hirvela, 1999). Previous literature has found that compared to other forms of language use, written record pushes learners to demand greater precision, which may encourage them to consult their explicit knowledge (Williams, 2012).

Third, *the contributed inscription reminds participants of previous ideas and initiates elaboration or negotiation on them, and possibly serves as resources for the emergence of new ideas/perspectives.* In this case study, we see the high frequency of occurrence of the medium transition from GS inscriptions to face-to-face discussions, and some of them are accompanied by the creation of new GS inscriptions. The qualitative microanalysis of interaction has suggested that group understanding develops productively in the pattern of medium transition—GS→CONT→GS, where the inscriptional device plays a role as promoting synergy. In semiotic terms, the inscriptions are representations not by reference to fixed concepts but by being in contextually defined relations to the situation at hand (Goodwin, 2003). Therefore, it is explained that the persistent inscription providing semiotic resource evokes and facilitates subsequent negotiations of meaning (Medina & Suthers, 2012;

Suthers & Hundhausen, 2003). On the contrary, when the group's verbal talk takes place without referencing to a prior inscription, the group understanding development is usually less productive as participants construct inscriptions without contextually making meaning (e.g., in the pattern of medium transition CONT→GS, the inscriptional devices function as accumulating).

In sum, the results of the study add to a growing research indicating the effects of representational tools on learning (especially on L2 learning). It is emphasized that the use of representational tools or the high frequent medium transitions does not necessarily imply that learning is effectively taking place. Exploring and understanding the specific functions of inscriptional devices in depth and in situ help us reflect on some of the practical implications of the findings and the discussion above for suggesting pedagogical design improvements by integrating a representational tool such as GS to facilitate language learning. However, this case study does not aim at predicting that all the identified functions will be played out in all the representational tool-supported L2 learning contexts. The scope of the study is limited to the examination of interactions that occurred among a class of small groups of students. As a result, the major limitation of the study is about the generalizability of the findings. In order to generalize the findings, there is a necessity to examine the appropriation of the representational tool in other lessons, with diverse task designs.

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