Group Cognition As Multimodal Discourse

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Abstract: Group cognition has been instrumental in the development of CSCL, thus further understanding its nature becomes necessary to sustain growth in the field.. In this paper, following Sfard's conception of thinking as communicating, we study group cognition from the perspective of discourse. We go beyond the more traditional stance on discourse by focusing not only on the verbal modes of communication, but also on nonverbal modes, including gesture, static image, and dynamic visualization. Specifically, we use the mathematical discourse of a group of preservice teachers, who are solving problems collaboratively with the support of a dynamic geometry environment, to illustrate the multimodal nature of group cognition.

Introduction

Our study is motivated by the need to better understand group cognition (Stahl, 2006) in order to ultimately promote collaborative knowledge building in computer-supported learning environments. Indeed, group cognition is not the sum of group members' cognition and cannot be decomposed into individual group members' cognition (Stahl, 2006). Instead, group communication itself should be the core of analysis for studying group learning for two reasons. First, according to Sfard (2008), thinking is a predominantly discursive. Second, group collaborative problem solving is accomplished no only by the interactions among group members but also by the interactions between group members and the learning environment. The focus of much research in the field of CSCL has tended to be solely on the verbal modes of communication (i.e., speech and writing). Such research provided insights in observing and interpreting verbal and written communication in collaborative learning. However, it did not take into consideration other modes such as gesture, image, and dynamic simulation. Indeed, communication in a group is a complex process mediated by multiple modalities if not simultaneous. Consequently, in this paper, we take into consideration multiple modes of communication to analyze the mathematical discourse of a group of secondary preservice teachers (PSTs) as they are solving problems collaboratively with the support of a dynamic geometry environment. The focus of the paper is how group collaborative observation and conjecturing is mediated by various communicative modes (Kress, 2001).

Context, Participants and Data Sources

Data was drawn from a teaching experiment (Steffe & Thompson, 2000) conducted in a large mid-west university. A unit about geometric transformations was designed for a geometry content course for secondary preservice teachers. One of the overarching goals of the unit is to develop the idea of geometric transformation as function or mapping taking points on the plane to points on the plane (Hollebrands, 2003). Fifteen PSTs enrolled in the course participated in research. Two groups of four PSTs were randomly selected from all the participants as focus groups. All eight PSTs in the focus groups were interviewed individually before and after the geometric transformations unit. Each focus group's class interactions were videotaped. PSTs' artifacts, including, notebook, worksheets, and screen records of computer activities, were collected. The episode we present here is from the first class of the unit. Prior to this activity, PSTs reviewed four types of geometric transformations (i.e., reflection, rotation, translation, dilation). With the support of the dynamic geometry environment, PSTs were examining the effect of the two functions with exact same rule but different domain:

Function 1: $f(x, y)=(x+y, x-y)$, where $(x, y) \in x^2+y^2=4$;

Function 2: $f(x, y)=(x+y, x-y)$, where $(x, y) \in R^2$.

The goals of the entire activity with 18 functions include: 1) elicit PSTs' misconceptions of geometric transformations, for example, two similar shapes means dilation; 2) help PSTs attend to the relationship between preimage and its correspondent points; 3) help PSTs understand the role of domain in defining geometric transformations. The episode we present is from one of the focus groups, which comprised of four PSTs: PST 1, PST 2, PST 3, PST 4. They were sitting in a hexagon shape table with one computer installed with dynamic geometry software, as it is show in Figure 1. A worksheet with the steps of constructing circle and preimage and image of the functions is available to each PST.

Figure 1. PSTs explore geometric transformations.

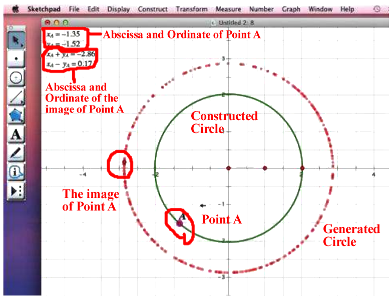


Figure 2. Screen shot of Function 1

Analysis

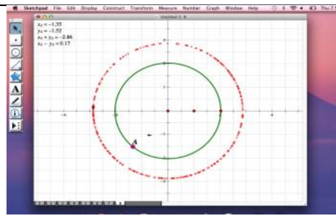
Since our aim is to illustrate the multimodal nature of group cognition in the aforementioned context, we focused our analysis on multiple communicative modes in collaborative group observation and conjecturing. To do this, we transcribed the video taking into account speech, actions and visual mediators, and arranged them by a combination of verbal turn-taking and action given that speech and action might not occur simultaneously. This way of defining turn-taking stands in contrast to the more commonly way of defining turns in which the main mode is speech and actions and mediators are attached to the turn as defied by speech. In doing so, we would be able to make explicit the use of multiple modes as they happened in the group communication. Our analysis focuses on what modes are utilized by the group in the collaborative observation and conjecturing activity.

Results

Here, we present two experts to illustrate how group collaborative observation and conjecturing can be conceptualized as multimodal communication. The first illustrates how the group's observations were accomplished by various modes namely, speech, static images and dynamic visualizations. The second shows how the group's conjectures were mediated by speech, gesture, and static images and dynamic visualizations. Moreover, we describe to what extent and how multiple modes shaped the group's thinking about geometric transformations

Excerpt 1: Collaborative observation mediated by speech, static image and dynamic visualization

Table 1: Transcript of examining the effect of Function 1.

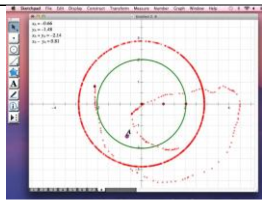
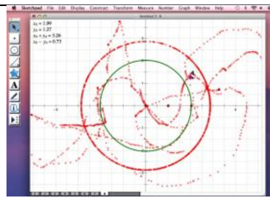
Time	Speech	Action	Visual Mediator
[00:05]		PST 4 is constructing a circle with radius of 2.	
…			
[00:36]	PST 4: there goes a circle, there goes a circle.	PST 4 used the touchpad to move preimage point A around the constructed circle.	 Figure. 3 Screen shot of the preimage and image of Function 1
[00:41]	PST 2: on the circle, they are all changed.		
[00:47]	PST 1: On the circle, Yes, everything changed.		
[00:51]	It appears to be dilation by [inaudible] degree.	PST 4 used the touchpad to move the curse onto the menu, and got ready for the next task.	
…			
[01:21]	PST 1: it is an even dilation.		

At the beginning, PST 4 performed a series of drawing actions. Following the given directions, PST 4 constructed a circle of radius 2 as the pre-image and defined point A on it. Then, she constructed the image of point A. After the constructions, she moved the point A on the circle. As point A was moving around the circle, a circle of radius larger than 2 emerged from the trace of the image of point A (Figure 3). PST 4 observed that the emerging figure on the screen was a circle. Her observation then becomes a shared group observation for two reasons: first, her speech and the momentary static image of the circle generated were made public at the small group; second, the observation was taken up by PST 2, as he pointed out that the all the points on the constructed circle were changed to the generated circle. PST 2's observation soon became a shared group observation for that the momentary static image of the circle was public and was accepted by PST 1. Based on the group collaborative observations of the dynamic visualization, PST 1 conjectured that the momentary static image appeared to be dilation. Again, this conjecture was accepted and refined by PST 1 based on her observation of the image on the screen.

In sum, we have shown that group observation and group conjecturing are not only mediated by the speech from group members, but also the dynamic visualization and the momentary static images. A multimodal analysis of the data let us conclude that two similar circles as shown in Figure 4 is a realization (Sfard, 2008) of the mathematical object of dilation in this group. Moreover, it allow us making the claim that as PSTs identify dilation, they attend to the relationship between the circles, rather than the relationship between a point and its corresponding image-point.

Excerpt 2: Acceptance and rejection of conjectures mediated by speech, image, dynamic visualization and gesture

Table 2: Transcript of examining the effect of Function 2.

Time	Speech	Action	Visual Mediator
[1:23]	PST 4: Let's see what happened.	PST 4 used the touchpad to move Point A in a circle-like path on the plane.	 Figure 2. A circle like path was created.
[01:43]	PST 4: It seems to be reflecting over a line. Do you see that?	PST 4 used the touchpad to move Point A in a circle-like path, then move the point from left to right around a line on the plane.	 Figure 3. Screen record of exploration of Function 2
[01:46]	PST 1: Yeah		
[01:48]	PST 4: But I don't know what line it is. It is not x=y.		
[01:49]	PST 1: It is not x=y.		
[01:52]	PST 2: So, wait …	PST 2 moved his pen to computer screen and aligned the pen to the emergent line on the screen.	 Figure 4. Hand and pen as the emergent line
[01:56]	PST 1: Doesn't that mean there is a point along that line is the same x?		
[02:00]	PST 2: So it is like...		
[02:03]	PST 1: not reflective over the line.		
…			

Following the given directions, PST 4 detached Point A from the constructed circle so that the pre-image could be any points on the plane. Then, she started moving Point A in a circle-like path on the plane, the trace of the image point of Point A appeared to be circle-like (Figure 2). Group members were observing the movement of the point, but nobody offered an observation or a conjecture. PST4 started moving Point A in a line-like path on the plane randomly. A "reflection line" was emerging as shown in Figure 3. PST # observed that the preimage points seems to be reflected over a line; this observation was was endorsed by PST 1. Then, PST 4 moved the points regularly around line x=y, which produced a cluster of points around the line x=y such as in figure 3. PST 4 pointed out that the reflection line is not x=y. PST 2 doubted at her conjecture, then he highlighted the reflection line emerging from the generated points by aligning his pen to the emergent line on the screen as shown in figure 4. As PST 1 keep moving Point A, more and more image points were generated, which do not fit the line x=y. PST 2's conjecture was rejected by PST 1.

In sum, we have shown that the acceptance or rejection of group observation and conjecture was not only mediated by the speech of group members but speech along with the consecutive static images from the dynamic visualization and group member gestures. Again, the analysis taking consider of multiple modes (i.e. speech, static images, dynamic visualization, gesture) allow us to conclude that PSTs did not see reflection as function on the plane, but realized it as reflection-symmetry effect that can be used to describe Function 2. Moreover, when exploring the effect of Function 2, PSTs moved Points A in three manners: circle-like path, line path, and swinging around line x=y. These actions indicated that PSTs had the intention to move point A in a systematical way, however, no perfect straight line movement were observed, such as movement along the x-axis, or line y=x, which revealed the constraint of the dynamic geometry environment: drawing perfect straight line, but not constructing straight lines, is not well accomplished by moving figures on computer touch pad.

Concluding Remarks

This paper presents an episode to demonstrate how PSTs collaboratively problem solving involves multiple modes of communication. In line with other researchers (Evans, Feenstra, Ryon, & McNeill, 2011; Perit Çakır, Zemel, & Stahl, 2009), we consider that mathematical knowledge building as the coordinated production and use of visual, narrative, and symbolic inscriptions as multiple realizations of co-constructed mathematical objects (Sfard, 2008). A contribution of the current study is to draw researchers' attention to the multimodal nature of group cognition and to find evidence of group collaboration, group thinking, and limitation of learning environment through multimodal analysis. Conceptualizing group cognition as multimodal discourse lead us to the conclusions on the two expects, which cannot be reached by attend to the verbal mode only.

References

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