

Gestures: Silent Scaffolding within Small Groups

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ABSTRACT

This paper describes how gestures are used to enhance scaffolding that occurs in small group settings. Sixth and eighth grade students participated in an elective science course focused on earth science concepts with a substantial spatial visualization component. Gestures that students used in small group discussions were analyzed and four patterns of gesture usage with scaffolding roles emerged: (a) Gestures highlighted essential parts of speech, (b) gestures provided information not provided in speech, (c) gestures were used in place of words not immediately accessible, and (d) gestures were adopted by other group members as a shared means of communication.

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A critical element of social constructivist classrooms is the scaffolding which takes place within what Vygotsky termed “zone of proximal development” (Roehler & Cantlon, 1997). Although the teacher is frequently the initiator of this scaffolding, research indicates that more capable others in the contexts of small group interactions can also successfully scaffold understanding of a task or a concept for a student who alone can not complete the assignment (Alexopoulou & Driver, 1996; Cazden, 2001; Kelly & Crawford, 1996; Windschitl, 2001). To successfully scaffold for another, ideas must be communicated in ways

that are accessible. Norman (1993, pp. 81-82) describes this as “. . . transforming our thoughts . . . into surface representations [e.g. words, gestures, objects] so that others can have access to them”.

The purpose of this study was to examine how students in small groups construct a shared understanding of earth science concepts. Specifically of interest were the gestures that students used to scaffold understanding for other group members. The spatial nature of gestures seemed a particularly appropriate focus for intense examination in the context of spatial activities used to teach earth science concepts (Driskell & Radtke, 2003; Haviland, 2000).

Roth’s review of literature on gestures (2001) indicated that gestures have been the focus of research in psychology, anthropology, and other related fields but little work has been done in the context of educational research. Although many studies have reported on the verbal interactions of students, the contribution of gestures in the knowledge construction process has largely been ignored (Roth & Lawless, 2002).

According to McNeill, gestures are “the movements of hands and arms that we see when people talk” (1992, p. 1). Kendon’s continuum is useful for differentiating the types of physical movement. At one end of the continuum is gesticulation, hand or arm movement almost always accompanied by speech. At the other end of the continuum is sign language which, although nonverbal, has many of the same structures and organizational patterns of speech (McNeill, 1992). The physical movements of most interest in this study are those near the gesticulation end of the continuum and will be referred to as gestures in the

remainder of the paper.

Several researchers have proposed how gestures may be advantageous to the individual: (a) Gestures may serve to stimulate thought in the gesturer (Goldin-Meadow, 2000), (b) gestures may serve to connect the concrete, external world, with the abstract, the internal world of thought (Graham, 1999), (c) gestures may lessen the cognitive load by decreasing the amount of talk required to communicate an idea (Goldin-Meadow, 2000), and (d) gestures may also provide individuals with an opportunity to share their thinking in a way that has less perceived social risk (Goldin-Meadow, 1999; 2000).

METHODOLOGY

Setting and Subjects

Middle grades students were selected for study because middle school is recognized as a time of intellectual transition (Baker & Piburn, 1997; Liben & Down, 1993; Newcombe & Huttenlocher, 1992; Plumert, 1994) and success in high school science courses may depend on adequate development of spatial skills during middle school (Baker & Piburn, 1997).

As a naturalistic study, the research site and subjects were selected to provide us with the greatest possibility for collecting quality data (Erlandson, Harris, Skipper, & Allen, 1993). We offered a six-week science elective class to a group of sixth graders and eighth graders at a local partner school. Students with a scholastic average of 85 or above were invited to participate in the elective classes. We felt that these students would be more apt to describe, discuss, and defend their ideas. Students were selected so the school's ratio of males to females and ethnic diversity was mirrored. The 6th grade class had 9 males (6 Caucasian, 3 African American) and 8 females (5 Caucasian, 3 African American). The 8th grade class had 9 males (5 Caucasian, 3 African American, 1 Hispanic) and 9 females (5 Caucasian, 3 African American, 1 Hispanic).

A 3-D Geo Mapping Course for Middle School Students

Mapping concepts were selected as the science content focus of the class. These concepts are developmentally appropriate, and the instructional activities used to teach these concepts have a significant spatial component. Three modules were developed dealing with space in two and three dimensions including flat and contour maps and sub-surface mapping.

As is characteristic of naturalistic inquiry we took active roles as both participants and facilitators (Guba & Lincoln, 1994). Two of the researchers, both experienced in teaching middle school science, served as the primary instructors for the course.

To encourage interactions, most of the activities were carried out in small groups of 3 members, resulting in six groups per class. The students chose their own groups which essentially remained intact for the six week period. Students were asked to work as equally contributing group members and to come to consensus before recording answers.

Data Collection and Analysis

For this study, transcripts of students' verbal interactions and videotapes during small group work were the primary data sources. During whole group sessions two video-cameras were strategically placed to capture interactions among class members and instructors. During small group activities six video-cameras with their associated wireless microphones were used to capture each small group's interactions.

After reviewing videotapes from small group instructional activities, videotapes for preliminary analysis were identified for analysis if members of a small group were collaboratively engaged in the instructional activity and if the nature of the collaboration was such that members engaged in extended verbal interactions accompanied by representational gestures (description follows). These selected videotapes drawn from the interactions of all 12 student groups were then viewed and gestures related to conversation about science were marked. McNeill's (1992) coding scheme was used to review the gestures and the context in which the gestures were made.

Iconic gestures providing a pictorial representation of an entity and metaphoric gestures, providing a pictorial representation of an abstract entity were marked. Thus, the unit of analysis, a representational gesture, consisted of one or more hand gestures used consecutively to communicate an idea. The context of each representational gesture was examined and gestures for which there was evidence of scaffolding by one group member for other group members were identified by two researchers reviewing tapes independently. Gestures for which consensus was reached were marked for further analyses. Patterns in the use of representational gestures to scaffold understanding in small group settings emerged from an iterative process (Strauss & Corben, 1990).

FINDINGS

As students worked in groups to negotiate meaning, ideas were communicated through gestures, sounds, verbal labels, verbal descriptions or drawings or a combination of these modalities. While all of these modalities had the potential to scaffold understanding for the other group members, four patterns related to the use of gestures as scaffolding mechanisms emerged.

Pattern 1: Students' gestures were parallel to or highlighted part of a verbal explanation. The most basic use of gestures with scaffolding potential were those that mirrored speech. Two examples from the videotaped small group interactions illustrate this use of gestures.

The first example is taken from an interaction that occurred when a group of students was trying to identify three different ways they could describe an area of the schoolyard to another student without showing a photograph of the area. In attempting to provide a description, one of the group members, Denise, uses words and gestures to indicate a flat area leading up to the hill (Figure 1a). Then she describes the slope (Figure 1b) and finally indicates the circular shape of the hill (Figure 1c).

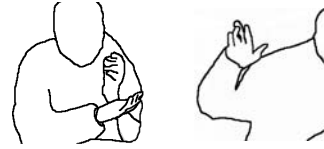
In the next example, students are attempting to interpret the markings on a contour map. Charles has indicated that one section of the map represents a hole. His partner doesn't understand how Charles interpreted the marks on the map in this way. Charles explaining while holding his fingers like the markings on the map moves them, providing a 3-D model of the markings on the map (Figure 1d). Interestingly, Charles doubts whether his explanation has been helpful. The following excerpt indicates that Charles successfully scaffolded Kurt's understanding.

Charles: Okay, what do you think?
 Kurt: That is right. I get it now.
 Charles: No, come on. What do you think?
 Kurt: I get it. Cause the line is going down. This is small lines going down. I get it.

Figure 1. Gestures that highlight or parallel words. a-c. Denise's description of the hill. d. Charles uses his hands to show the inward movement of lines by pushing his fingers together and then apart.



a. Denise It is like very plain



b. Denise: And then it goes up.



c. Denise: Like a hill going like around.



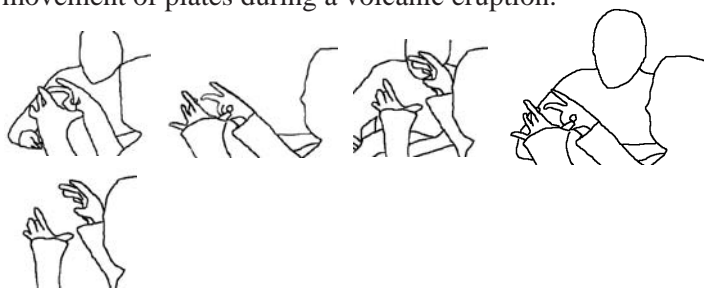
d. Charles: Cause it is right here. Cause it is going inward. The lines are going inward.

Pattern 2: Students unable to communicate their ideas exclusively through a verbal modality would rely on gestures, which might or might not be accompanied by verbal labels, descriptions and/or sounds. If verbal labels/descriptions accompanied the gesture, the gesture was more complex than the label. In contrast to the previous example, the use of gestures to describe the hill in the schoolyard by a student in another group provides additional information for the other group members. As the group ponders a response, Jane recalls a depressed area on the hill and repeatedly gestures the size of the hole relative to the size of the hill (Figure 2a).

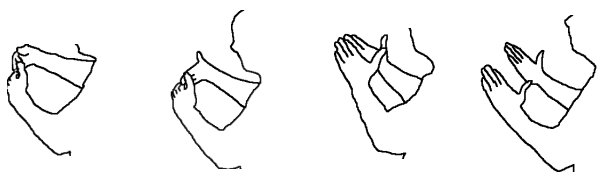
In the next example, students seek an explanation for a bulge growing on the side of a mountain. In this activity, students first listened to a verbal description of how the physical features of Mount St. Helen changed over the 2 months prior to eruption. Groups were then given a picture of the outline of the mountain for the time period matching the verbal description and were asked to construct a cross-section drawing to illustrate what they thought was going on inside the mountain during that time. In one

group, students begin to tentatively make suggestions about the cause of the changes inside the mountain. Although gestures sometimes accompany a group member's suggestion, the gestures are as tentative and ill formed as their ideas seem to be. They unenthusiastically report their ideas to the instructor who briefly comes by to monitor progress. Suddenly Mike excitedly says "I just remembered this from science. . ." He explains his ideas about the cause of the changes in the appearance of the mountain, attributing the cause to plate tectonics, gesturing plate movements (Figure 2b-c). His partner's enthusiasm for Mike's idea is illustrated when she calls out to the instructor "He just said something really, really interesting . . ." Although Mike's answer is accepted by the group, other group members don't use these gestures as they continue to discuss their answer.

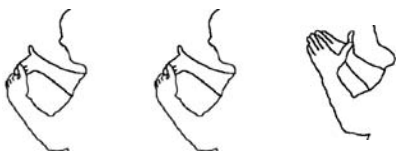
Figure 2. Gestures enhance words a. Jane's description of the hill. b-c. Mike uses both of his hands to model the movement of plates during a volcanic eruption.



a. Jane: Oh yeah and there is like this big brown spot on the hill. Like this big brown hole.



b. Mike: The things go together, plate tectonics and they go up.



c. Mike: When the earthquakes happen it shakes together and it goes up.

Pattern 3: Use of gestures and sounds was sometimes sufficient to trigger verbal labeling by the speaker or by others in the group. Sometimes students were observed

to be at loss for words when trying to communicate with other group members. At these times gestures were often used in place of words to communicate an idea. In this first example, Kurt's use of gestures is sufficient to trigger his remembering the word. In this activity students are using flat maps to answer a series of questions about direction and elevation. Kurt has answered a question about direction and one of the other group members challenges his answer. Kurt tries to explain how he determined direction by repeatedly moving his hand on his chest to model the shape of the compass rose (Figure 3a). Finally after repeated gesturing Kurt remembers the word compass.

In this second example, students are working with a road map of a local community to respond to a series of questions about the area. Jason is trying to measure the distance from one city to another but is having trouble recalling the name of the tool he needs to determine the distance. He uses his fingers to represent the scale on a map (Figure 3b). This is sufficient for Tyson to both label and locate the object represented by Jason's gesture (Figure 3c).

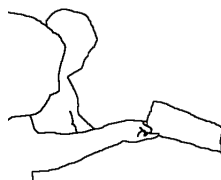
Figure 3. Gestures scaffold scientific language a. Kurt traces the shape of a compass rose on his chest. b. Jason gesture communicates his need by using his fingers to represent a scale. c. Tyson responds.



a. Kurt: um, a thing, what is it called?



b. Jason: Where is the little thing that you measure?

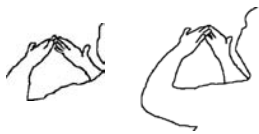


c. Tyson: It is, hold up, we got the, we got the scale right here.

Pattern 4: Spatial information could be effectively communicated through gestures to the extent that students could adopt others' representational gestures for communicating their ideas. In the same Mount St. Helen's activity described previously, another group struggles for an explanation. Eileen has suggested that plate tectonics might be responsible for the changes. Then she demonstrates plate movements using gestures (Figure 4a). Ed agrees and he begins to use gestures to mirror the gestures Eileen continues to make (Figure 4b). The third member of the group, Jane, agrees and gestures plate collision (Figure 4c).

The conversation continues as the group works through this explanation. Ed describes the plates as stacking up (Figure 4d). Eileen does not agree with Ed's idea and further explains her thinking about the plates (Figure 4e). Ed accepts this idea and asks for clarification (Figure 4f).

Figure 4. Shared gestures as shared communication. a. Eileen uses her hands to model movement of plates. b. Ed (left) gestures subduction while Eileen (right) alternately gestures subduction and collision. c. Jane builds on Eileen's explanation by moving hands upward to show movement of plates. d. Ed suggests plates stack. e. Eileen offers an alternative idea. f. Ed accepts the sliding motion of subduction.



a. Eileen: Yeah because they can do this thing. They can do that or they can go together.



b. Ed: They could probably.



c. Jane: Yeah I think they go like this zoom.



d. Ed: Because I mean like plate tectonics are like stacked up. We don't know how big they are.



e. Eileen: I thought the forces were going against each other and finally one of them gives.



f. Ed: One of them kind of slides in doesn't it?

DISCUSSION

Looking at gestures as a type of scaffolding interaction added another dimension to understanding shared construction of knowledge in small group settings. Four scaffolding roles of gestures were noted. Scaffolding by iteration occurred when speech and gestures were parallel, providing the same information. However, gestures added a 3-D component which may be vital in the context of spatial tasks. Second, gestures provided the opportunity for students to add to the ideas they were communicating verbally. Third, gestures which triggered verbal labeling of a concept or idea scaffolded the use of scientific language. And the fourth use of gestures scaffolded a shared method of communications but rather than a shared verbal language, gestures provided an additional modality to lead to "shared conversation."

Clearly, gestures were used by students to communicate ideas to other students, however the significance of the contribution seemed to depend on the role of the gesture. Although we have no evidence from this study that the use of gestures which matched speech significantly added to the scaffolding potential of the interaction, using multiple representations for communicating ideas is widely believed to enhance understanding (Roth, 2001). Further,

the use of gesture to highlight part of an explanation may make salient the important part of an idea. This may provide a level of concreteness for students who are transitioning to formal reasoning.

Closely related to parallel gesture was the use of gesture that subtly enhanced speech. While parallel gesture made salient an important part of a verbal interaction, this use of gesture made salient an important part of an idea not expressed in speech. This use of gestures could be interpreted as relieving the cognitive burden (Koschmann & LeBaron, 2002) but in the context of a spatial task may have assisted in representing the mental image (Valenzeno, Alibali, & Klatzky, 2003).

As reported in the literature we also found gestures used in place of speech when students were at loss for words. This use of gestures was advantageous when it triggered word retrieval for the individual or for others in the group. Using gestures when words are not so familiar as to be readily available permits continued conversation until the correct terminology can be supplied, supporting the notion that scientific vocabulary may be enhanced and reinforced by this use of gestures (Roth, 2002).

We found the uses of convincing gestures and shared gestures most interesting in terms of the scaffolding potential of the actions. The adoption of a gesture by other group members reveals the shared nature of the discussion and may be a way to measure group effectiveness (Roth, 2001). The finding that gestures can be used and added to by others has been reported in teacher-student interactions (Furuyama, 2000) but little has been done to look at shared gestures in a small groups. When is a gesture most likely to be shared in small group conversation? Does this come about because of shared group experiences that have lead to similar stored mental images? In the two examples of the interactions during the Mt. St. Helen's activities, gestures were used to communicate the idea of plate techtonics in volcano eruption. In the first example, although the use of words and gestures clearly provided a reasonable explanation for other group members, there was no indication that the group members had similar stored images. However, the gestures in the second example were readily adopted by other group members and used in the continuing conversation. This leads to questions about the stability of an individual's understanding constructed in the small group

setting when the individual seems convinced by a partner's idea but does not use or build on it. A term such as plate tectonics, which had not been introduced in our class, may have promoted the use of gestures to ensure shared understanding.

The use of gestures to defend ideas certainly bears more research. Of particular interest might be looking at gestures resulting from a common culture and tracing the origin of shared gestures. Do some types of instructional representations promote development of stored visual images? Are gestures more common in some types of tasks, such as spatial tasks, than others?

FUTURE RESEARCH

The National Science Education Standards (National Research Council, 1996) recommends engaging students in scientific dialogue in small groups. Understanding how and why group interactions can lead to knowledge construction must continue to be investigated inclusively (Bianchini, 1997) and gestures play a significant role in the communication process. Further exploration of frequency and mimicry of gestures to measure how well a group is functioning is also recommended as having potential for measuring group effectiveness. In addition, research on cognitive gains of the gesturer as well as those who mimic the gestures could provide information about the relative impact of gestures as scaffolding mechanisms.

In this study we examined only a small number of the total number of gestures used in small group interactions. We ignored those gestures that we deemed social in nature. We also did not consider pointing gestures, gestures for emphasis, and gestures that serve as punctuation showing a continuity or discontinuity between ideas. However, all these gestures deserve examination as they may represent key variables impacting the negotiation process. We should continue to look at gestures as silent scaffolding that can impact learning in small group settings.

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