Utilizing Discourse Analysis to Explore the Merits of Nonverbal Communication in Higher Education Mathematics Classrooms

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Discursive interactions have been of great interest to researchers studying students' sense of belonging in the classroom. The study of discourse helps us understand positions of authority and agency, as well as creating a common language to describe expected social roles in student-teacher and student-student interactions (storylines). Positioning theory provides the groundwork for understanding how our beliefs about social roles influence how we express ourselves. In each of these areas, verbal communication is typically studied directly, with nonverbal communication used as confirmatory or add-on illustrations. This study centers on instructor nonverbal communication, using empirical data from an observation of a higher-education mathematics classroom across two class sessions. We seek to identify how the instructor's use of classroom space (proxemics) and body movement (kinesics) demonstrates the assignment and shifting of power structures, as well as the enactment of storylines.

Keywords: Positioning theory, discourse analysis, nonverbal communication

Mathematics, as a discipline, is notorious for creating the unfortunate dichotomy of "math people" versus "non-math people" in the classroom. Identifying oneself as a "non-math person" engenders a lack of confidence, a high incidence of math anxiety, and a significant impact on the rate at which students pursue STEM careers (Beilock, 2019; McDermott-Murphy, 2022). According to a study by Bressoud (2015), Calculus 1, a course required for most STEM and some non-STEM majors, had significantly higher drop/fail rates and lower levels of student confidence. One possible finding Bressoud identified was in the connection between student confidence, enjoyment, and a desire to continue mathematics as related to "good teaching" (Bressoud, 2015).

"Good teaching" and "ambitious teaching," according to Bressoud (2015), include qualities such as eliciting student thinking, holding frequent whole-class discussions, helping students become better problem-solvers, and providing time for student thinking. Each of these qualities positions students as co-contributors to classroom knowledge, sharing authority between teacher and student, creating a narrative of "teacher as facilitator of learning" and "teacher as participant in learning" (Drageset & Ell, 2024).

In this study, we follow one instructor, Kim (pseudonym), to examine how he positioned students and the messages he conveyed through verbal and nonverbal cues. After determining the importance of Kim's nonverbal communication through an initial analysis of verbal communication, the research question we sought to answer was: How does nonverbal communication demonstrate the assignment and shifting of authority and the enactment of storylines?

Few studies exist in mathematics education discourse research that describe communication acts beyond gestures. Therefore, this study lays the groundwork for understanding the relationship between verbal and nonverbal communication and examines the merits of nonverbal communication in mathematics education. We first consider the theoretical frameworks employed to understand the verbal and nonverbal communication in Kim's classroom discussions. We then describe our process for analyzing instances of verbal communication,

which led to the discovery of the central role of nonverbal communication. Lastly, we will discuss the implied messages conveyed by Kim's nonverbal communication acts and their impact on student engagement.

Theoretical Framework

Communication is a collection of socially constructed verbal (words, tone, pauses, and inflection) and nonverbal (gestures, gazes, movements) cues that deliver messaging consistent with our contextual understanding. Researchers in mathematics education have studied discourse extensively as common phrases used in the classroom (Biber & Barbieri, 2007; B. Herbel-Eisenmann et al., 2010), as constructors of relationships of power and authority (Langer-Osuna & McKinney de Royston, 2017; Wagner & Herbel-Eisenmann, 2014), or as indicators of social roles and inherent responsibilities (Davies & Harré, 1990; Drageset & Ell, 2024; B. A. Herbel-Eisenmann et al., 2015).

Discursive analysis, using positioning theory, can be applied to both verbal and nonverbal communication to ascertain the subject's beliefs and attitudes. Most discursive analyses have focused on verbal communication (words, utterances, intonation), while using nonverbal communication (gestures, facial expressions, movement) as an add-on to provide further depth to their findings. In this analysis, verbal communication analysis led the research team to a deeper conversation about nonverbal communication. Therefore, we will begin with a discussion of the theoretical basis for our verbal analysis, followed by a discussion of the nonverbal frameworks.

Analysis of Verbal Communication

Categories. Teachers' utterances can be classified into seven distinct statement types based on their intended purpose. For example, bookend statements summarize a previous activity and serve as a springboard to the following activity. Norm-setting and “math talk” center mathematics within the social and contextual setting. Other categories include affective discourse, technical tools, discursive moves, organization, and information. Identifying the purpose of teacher statements allows for comparison across disciplines, instructors, or class periods (Knott et al., 2008).

Positioning Theory. Discourse comprises a collection of communication acts that convey messaging about our perceived roles and the roles we attribute to others. In a classroom setting, for example, a teacher may see themselves as a facilitator of discussion, with students as primary consultants who provide the necessary dialogue to engage with and interact with other students. Students may expect to be the recipients of the knowledge that the teacher provides. In this case, they may perceive themselves as passive observers, whereas the teacher is the subject-matter expert. Both sets of expectations *position* students and teachers into roles based on their individual understandings of the storyline of student/teacher interactions. These roles are negotiated constantly and can change from moment to moment (Davies & Harré, 1990; Drageset & Ell, 2024; B. A. Herbel-Eisenmann et al., 2015).

Analysis of Nonverbal Communication

Several types of nonverbal communication are identified in disciplines such as linguistics, sociology, psychology, and social anthropology. For this study, we focus on two: proxemics and kinesics.

Proxemics. The distance in a conversation varies with the relationship between the speakers. For example, if two strangers are talking, they tend to naturally stand further apart than siblings. Farsani and Rodrigues (2021) highlighted four distances commonly used in discourse: intimate

space (up to 45 cm), personal space (up to 120 cm), professional space (up to 370 cm), and public space (more than 370 cm). In a classroom setting, for example, teachers speak at the front of the class using public space. When speaking with small groups of students, teachers may step closer, into the professional space, or into personal space in more relaxed settings (Farsani & Rodrigues, 2021).

Kinesics. Body position, movement, and facial expressions are all examples of kinesics (Khan et al., 2025). This includes movements such as folding the arms, leaning forward or back, shrugging the shoulders, or using a rolling hand gesture to indicate that the topic continues (or should continue).

Methodology

As part of a larger study, one algebra instructor, Kim (pseudonym), at a Midwestern university was observed twice within two weeks at the end of the Spring 2025 semester. The class was being conducted using the Building Thinking Classrooms methodology (Liljedahl, 2021). In the first observation, the tables were arranged in rows, with some rows near the side walls, leaving little room for movement. In the second observation, tables had been moved into clusters and away from the walls. In both class periods, vertical whiteboards were affixed to the walls, with students clustered in groups around each board. Kim was selected for analysis because of his approach to teaching in higher education, changes in furniture arrangement, and his use of technology to decenter the classroom.

At the front of the room was a table with a technology station, next to which was the screen for the overhead projector. Kim had his laptop set up and alternated the overhead display between a Desmos (now known as Amplify) activity on the laptop and an Apple TV setup connected to his iPad. In this way, he could walk around the classroom, taking notes on his iPad visible to the students, and, during large-group discussions, he would sometimes hand the iPad to a student to operate the technology without walking to the front of the room.

Swivl Robot technology used a recording device on a lanyard to capture audio/video recordings that followed Kim's movement around the room. Four additional recorders were placed at tables around the room to pick up student voices during small-group discussions. These additional recorders could be enabled and disabled during analysis to improve transcript accuracy.

Data Analysis

Following the observation of each class, the resulting audio/video recording was used to create a transcript. During the cleaning process, special attention was paid to nonverbal communication. The transcripts were independently coded into categories and positioning acts by each member of the research team.

The research team then convened to compare their individual coding of the transcripts. When interrater discrepancies occurred, the researchers relied on the context of the instructor's statement to reach an agreement. This involved listening to the instructor's statement in the recording while attending to tone, phrasing, nonverbal cues, and student reactions.

During these deliberations, the research team realized their reliance on nonverbal cues to more accurately categorize the instructor statements in question. While the team had previously noted common hand gestures, the researchers began using more subtle physical movements to gain a deeper understanding of the instructor's statements. This included how the instructor positioned himself among the groups, how he leaned toward or away from a speaking student, and shifts in posture that drew attention to other groups.

To supplement their understanding of these nonverbal communication acts, the research team created a map of teacher movement in 20-minute segments at the beginning, middle, and end of the two observed classes. To do so, a two-dimensional scale of the classroom was created for each observation because the furniture was moved between the two observed class sessions. Researchers then watched the recordings and manually traced the instructor's physical movements through the classroom using different colors to represent the "trips" that occurred during the 20-minute segments. A "trip" was considered to be the path that Kim took before returning to a given starting point, typically the front of the classroom or the podium. Researchers then noted specific patterns that emerged in Kim's movements.

Results

The research team identified four primary categories of nonverbal communication consistently used by Kim: position in physical space, gestures, movement, and pacing. We will discuss the patterns identified for each of these categories before addressing their implications.

Position in Physical Space

Across both observations, Kim used the classroom space differently during small-group and large-group discussions. During the first observation of large-group discussions, Kim spent most of the teaching time at the front of the classroom, asking students in their groups questions and using the vertical whiteboard. In the second observation, Kim used technology to teach from the center and the back of the room, with only a brief period of instruction from the front.

During small-group discussions, Kim adopted several physical positions in relation to the groups. When providing students time to brainstorm and collaborate on ideas, Kim primarily positioned himself in the circle created by students around the vertical whiteboards, as in Figure 1. However, as time progressed and Kim shifted to more direct teaching, he tended to stand behind the groups, either speaking directly to them or over their shoulders as they continued working on their boards.

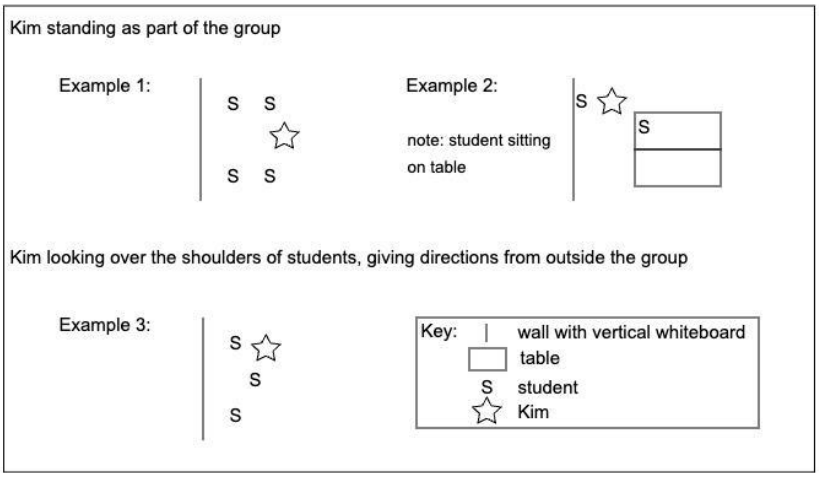

Figure 1. Kim's physical positioning around small groups.

Gestures

Physical movements were used to help students differentiate among ideas and to aid memory recall. When discussing the concept of "balancing," Kim alternated raised hands to indicate the rising and falling of opposite sides of a balance beam, as opposed to the leveling of a bar chart,

demonstrated by a line drawn in the air. Kim repeated these movements with each group toward the end of the small-group discussion, connecting the gestures to the two ideas.

Pointing was consistently used to convey three distinct ideas. Kim used pointing to indicate the person he was directly addressing, often accompanied by a lean inward as if sharing a secret. He also used pointing to signal when he wanted to capture a statement, thereby validating the response. Lastly, he used pointing to direct the students' attention to either another group, a computer, a vertical whiteboard, or the class notes projected on the screen.

One notable use of gestures to direct student attention occurred when Kim crossed his arms, set his shoulders beside a student, and leaned back as if they were both reclining on a couch. The student then followed his gaze and shifted again when Kim moved. This movement had a more lasting impact than a simple point to shift focus.

Another method Kim employed to direct attention was general arm sweeps, such as when he asked a speaking student to "tell them," motioning to the other students in the class. The student looked up and followed Kim's arm around the room before speaking again, a little louder than before.

Movement

A class norm that had clearly been established was to look at other whiteboards when a group became stuck. After conversing with one group, Kim suggested they ask another group, then turned and walked toward the group. The students followed, and when Kim stepped back, the group continued in the desired direction.

In large-group discussions, Kim would turn his body to face the projection screen while students discussed their work, thereby providing a model posture for students to emulate. Student gaze would then shift from Kim to the board, following his gaze and posture.

This happened again when in a large-group discussion, shortly after Kim had been teaching from the middle of the classroom. Kim had asked a student to show the class their ideas on the iPad. The student took the iPad and moved to the center of the classroom, mimicking Kim's movement.

Pacing

During shorter conversations, Kim moved and talked very quickly, setting the tone for the classroom discussion. In small groups, Kim quickly provided validation or correction after an idea was shared. He moved away briskly after a group began discussing his answers to their questions. When releasing the class to their groups, he gave directions and then issued a curt "Let's go" to signal that the students should act quickly. Occasionally, this fast pace meant that he spoke over students as they tried to voice their thoughts. An interesting consequence occurred during a large-group discussion, when a student spoke over him, picked up the iPad, and provided an answer before Kim was ready to relinquish authority. In this case, a student appeared to take on the role Kim demonstrated.

However, this was not always the case. When students were working in small groups, Kim would saunter around the room along a set path, such as a circle in the middle of the room, listening to conversations, reading the students' vertical whiteboards, and then checking online for their responses in the Desmos activity. At these times, he provided opportunities for students to think, collaborate, and formulate their own responses. Maps of these moments showed dark paths along which Kim repeatedly moved in the same direction.

Each of the nonverbal cues discussed above (position in physical space, gestures, movement, and pacing) conveyed messages directly to students, sometimes overriding verbal messages. In

the following section, we discuss the implications of this messaging on the classroom environment and the direct impact on students.

Discussion

In response to our research question, two primary areas of analysis were examined directly: the assignment and shifting of authority and the enactment of storylines. One unintended result became apparent as well: agreement (or lack thereof) between verbal and nonverbal messages.

Assignment and Shifting of Authority

Authority figures are participants who direct attention, whose ideas are taken up, and who have control over the situation (Bishop, 2012). In analyzing nonverbal communication, we can observe the student and teacher posture, physical position, and classroom/group attention to identify authority at each moment. In this study, the shifting or sharing of authority was most clearly identified with shifts in student focus and with students mimicking Kim's behavior.

The researchers found that Kim shifted students' attention solely through nonverbal cues, altering his posture and gaze toward their work. The student mimicked these movements, thus accepting the directional shift without any verbal acknowledgment from Kim. Their change in physical position followed his direction without explicit verbal direction.

On another occasion, he taught from the center of the classroom. When a student offered to answer a question, he handed the iPad to the student and stepped back. Without verbal prompting, the student took Kim's place in the center of the classroom to speak. The authority shifted to the student as Kim stepped aside, de-centering himself.

Storylines

In verbal communication, we talk about storylines of "teachers as providers of insight," "teachers as facilitators of learning," or "teachers as participants in learning" (Drageset & Ell, 2024). When examining Kim's observation recordings, we observe elements of the first two at various points during the class periods.

At times, Kim joined the student groups, standing alongside them in a circle. In these moments, he leaned in when asking questions, gesturing to the student or to the board. As he listened to students, he turned his whole body toward them, frequently with his head tilted to the side. Between groups during this time, Kim circled the classroom at a distance and observed students' conversations. These movements suggested that he participated in the discussion, in which students were the providers of collaboratively constructed knowledge. Our interpretation was validated by his verbal communication acts, which included soliciting students' thinking, highlighting key concepts articulated by students, and encouraging collaboration within and between groups.

At other times during the two observations, Kim took a more direct approach to teaching, standing behind groups to talk over their shoulders and sometimes pointing through students to the board. Listening to his language use, he was providing more direct instruction in these moments, enacting a storyline of "teacher as provider of insight."

While the two storylines were both present, they do not necessarily indicate conflicting messages. Teachers frequently move between storylines during a single class period, taking on different roles and shifting their expectations of student behavior (Drageset & Ell, 2024).

Agreement (or Lack of) in Messaging

In analyzing nonverbal communication through verbal communication, the research team hypothesized that the two would align. Before the observations, Kim stated that he intended to use students' thinking to create a productive learning environment. Classroom norms were established that students would work together, with Kim facilitating their discussion and occasionally providing input. Students were encouraged to try new things, take chances, and participate collaboratively.

During student group work, when Kim followed a set path around the room, observing conversations and reviewing students' work on boards, he created space (both physical and metaphorical) for students to collaborate. At times when students asked for help or when he noticed students were stuck, he facilitated discussion by asking questions and requesting that students provide feedback to one another. These are the moments he moved to a physical position directly in line with the students in the group. When responding to questions, he validated correct responses by pointing to the student who provided the proper response and leaning in toward them. Leaning toward a student in this manner reduces the distance between Kim and the student, shifting from personal to intimate space. All of these verbal and nonverbal cues indicate a shared space between the student and teacher. Students are encouraged to provide information, and the teacher serves as a facilitator.

However, there was a significant period during which the nonverbal cues conflicted with the established classroom norms and occasionally with the verbal cues. During the observations, Kim began to speak over students, moving the conversation along at a quicker pace. He began walking briskly and visiting groups for shorter periods. When he visited groups, he spoke to them over their shoulders and, occasionally, pointed at their board between their shoulders. The faster pace and Kim's removal from the groups led to a shift in the storyline and a new expectation that students respond quickly and accurately, which conflicted with the class's explicit and implicit norms. Although student perceptions were not measured in this study, some students were hesitant to speak in the groups at this time, and many looked to one another while he was speaking, which seemed to indicate some unease.

Identifying conflicting messages provided a mentoring opportunity for Kim, who was unaware of the change in his behavior and its impact on student engagement.

Conclusion

Discourse analysis is an effective method for gaining insight into classroom interactions. While it is tempting to focus primarily on verbal communication, nonverbal communication provides a wealth of information that can highlight hidden messaging or infer interpretations of messaging.

The limitations of a study such as this, however, are that perceptions of nonverbal communication acts differ across cultures, making international classrooms difficult to analyze. Future research may include the cultural contexts of the ethnicities represented by the teacher and the students present. Also, obtaining the teacher's intended messages and the students' perceptions of these communication acts could be helpful.

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