

## Responding to STEM Students' Gestured Candidate Responses

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**Abstract:** We demonstrate a way in which teachers can be responsive to students' multimodal contributions in whole-class STEM discussions. To answer teachers' questions, students sometimes use representational gestures to provide unspoken, "off-the-record," tentative responses. By attending to these *gestured candidate responses*, teachers can preview students' potential contributions to the discussion and ratify the contribution. Ratified contributions can be taken up by the teacher and shared with the class. This study contributes to a better understanding of the nuanced roles gesture plays in STEM classroom discourse.

### Gesture and responsive teaching in STEM learning

In STEM classrooms, whole-class discussions provide important opportunities for students to co-construct new knowledge (O'Connor & Michaels, 1996). During these discussions, the body is an essential resource for meaning-making: STEM teachers and students regularly use gesture to share and negotiate new understandings together (e.g., Singer, 2017). In particular, students use gesture to make sense of abstract concepts and explain STEM ideas before they have mastered the complex languages of STEM disciplines (e.g., Roth & Lawless, 2002).

STEM educators can take up and be responsive (Coffey et al., 2011) to students' gestures in a variety of ways. These include (1) encouraging students to elaborate their gestures when there are discrepancies between gesture and speech (e.g., Flood et al., 2020), (2) repeating students' gestures to help students connect embodied ideas with rephrased speech (e.g., Alibali et al., 2019; Shein, 2012), and (3) reformulating and extending students' gestures to refine and elaborate the spatio-dynamic imagery available to students (Flood, 2021). A number of embodied responsive teaching techniques have been identified (Flood, et al., 2020; Flood, 2021). By eliciting, attending to, and responding to the ideas students share with their hands and bodies, educators help students make new STEM discoveries, thus enriching opportunities for learning (Flood et al., 2020; Flood, 2021).

Our current study extends previous work on the role of teachers' responsiveness to gestures in whole-classroom discussion (Flood, 2021). We demonstrate how students in physical science class use gestures to make "off-the-record," tentative contributions – *gestured candidate responses* – to answer teachers' questions. By attending to these gestured candidate responses, teachers can take stock of what students could contribute to the ongoing discussion, and then decide to pursue and endorse the contribution, for example by taking up and repeating the gesture publicly. Teachers can also invite students to elaborate on the idea, themselves.

### Methodological approach

We draw on a video corpus of two-week long energy units in two eighth-grade science classrooms in the Northeastern U.S. The classrooms feature project-based learning and contain numerous interactive whole-class discussions where students share ideas. We located instances where students used representational gestures to respond to teacher queries. Then, inspired by ethnomethodological conversation analysis, we microanalyzed the embodied communicational practices of teachers and students in these instances to understand how and when gestures were deployed and coordinated with other interactional resources (e.g., gaze, talk).

### Findings: Teachers take up gestured candidate responses

We present a representative example from our study to demonstrate how teachers can take up students' gestured candidate responses in classroom discussions. In Excerpt 1, the class is discussing energy and friction (1). Energy cannot be directly perceived and must be studied through the use of indicators that can be measured, like light, heat, and motion. To discuss this problem with students, the teacher reminds the class of another use of indicators they have seen: She asks the class to recall friction indicators, and students offer sound (hearing a door creak) and seeing a model car veer as examples. She asks them to think of more, but no one volunteers. After a pause (E1.02), the teacher asks the class to remember how they explored friction through demonstrations (E1.03-04).

Dan responds, speaking inaudibly (E1.05). It is unclear if the teacher can hear what he says, and students across the room would not be able to make out his words. Dan's response is multimodal, and he looks toward the teacher as he talks and gestures, rubbing his hands together (Figure 1a). Rubbing your hands is a good way to *feel* the presence of friction, since the rubbing generates heat and resistance, both indicators of friction. At this moment, the teacher's head was turned slightly away from Dan, and she was scanning the room. However, she seems to catch Dan's gesture from the corner of her eye. As soon as Dan starts rubbing his hands, she turns her

head toward him. By not officially bidding to answer with a raised hand, speaking so as not to be heard by the rest of the class, and gesturing, Dan marks his response as a *candidate* for the teacher to acknowledge or ignore.

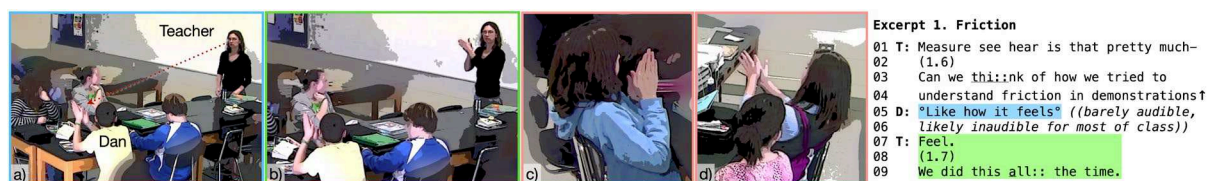


Figure 1. Taking up a *gestured candidate response* of hand rubbing. Blue highlighted talk corresponds to image (a) and green highlighted talk to image (b). In (c) and (d) other students copy the hand rubbing.

As Dan continues to rub his hands together, the teacher also holds her hands up in view of the whole class and begins to rub them together (Figure 1b), ratifying Dan’s response. As she takes up and repeats Dan’s gesture, she says loudly out to the class “Feel” (E1.07). She continues to rub her hands together and look around the room. Many students also start rubbing their hands: Of the 15 students in the room, seven repeat the gesture, and the teacher continues to rub her hands together for 16 seconds as other students take up the gesture.

By attending to Dan’s gesture, taking it up, and repeating it for the whole class, the teacher shares Dan’s embodied knowledge with everyone. Most students would not be able to hear Dan, and in addition, many also likely did not see Dan’s hands because of where they were seated. By repeating the hand-rubbing, the teacher provides implicit feedback about Dan’s response, endorsing the gesture as a valuable embodied way of knowing about friction. When other students repeat the gesture, they have an opportunity to also experience *feeling* indicators of friction (e.g., heat, roughness). O’Connor and Michaels (1996) argue that one of a teacher’s key jobs in orchestrating classroom discussions is to “hold students’ ideas in view.” By attending to Dan’s gestured candidate understanding and repeating it for all to see and feel, the teacher in Excerpt 1 literally does just that.

## Conclusion

By attending to *gestured candidate responses*, teachers can take up and broadcast students’ tentative ideas to the class. Our study contributes to a growing body of work that demonstrates how responsive teaching is an embodied, multimodal phenomenon, where teachers attend and respond to disciplinary substance (Coffey et al., 2011) not just in what students say, but also in the meanings students convey with their hands and bodies (Alibali et al., 2019; Flood, 2021; Shein, 2012). Our efforts to investigate the ways instructors attend and respond to gestures during whole-class STEM discussions contribute to more systematically characterizing the many forms and functions of embodied communication in STEM learning. Our future work will continue to explore and characterize the different roles gesture can play in organizing whole-class STEM discussions.

## Endnotes

- (1) We use Jeffersonian Transcript conventions: Degree signs for especially quiet speech (°°); underline for emphasis; up arrows for rising intonation (↑); timed pauses in parentheses (2.5); and colons to denote elongated syllables (::).

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