OPERATIONALIZING ACCESS FOR STUDENTS: MAKING MEANING OF TASKS, CONTEXTS, AND LANGUAGE

Amanda Sugimoto
Portland State University
asugimo2@pdx.edu

Eva Thanheiser
Portland State University
evat@pdx.edu

Kate Melhuish
Texas State University
melhuish@txstate.edu

M. Alejandra Sorto
Texas State University
sorto@txstate.edu

Autumn Pham
Portland State University
autpham@pdx.edu

Untangling the relationships between teaching, learning, and content is complex. This study focuses on one aspect of these relationships, i.e., the at times challenging role that language can play in mathematical tasks, discussions, and student access. The authors analyze two video banks to identify and operationalize combinations of teacher and student actions that support student access to mathematical tasks and language.

Keywords: Classroom Discourse, Instructional Activities and Practices, Equity and Diversity

Mathematics education reforms and standards movements highlight the vital role that language and discussion plays in teaching and learning (National Council of Teachers of Mathematics (NCTM), 2010, 2014; National Governor's Association Center for Best Practices & Council of Chief School Officers (NGACBP & CCSO), 2010). Yet, the complex nature of mathematical tasks and discussions can become an obstacle for students' participation in mathematics classrooms (Aguirre & Bunch, 2012; Chval & Chavez, 2012). In order to support student access, teachers must develop practices that facilitate student access to mathematical tasks and language (Boaler & Staples, 2008; Chval, Pinnow, & Thomas, 2014; Staples, 2007).

This study comes from a decades long collaboration between K-12 schools, a nonprofit education organization focused on professional development and coaching for teachers of mathematics, and mathematics education faculty. In recent years, the partners collaborated to develop an app-based observation tool (Melhuish & Thanheiser, 2017) designed to provide teachers with formative assessment data about their implementation of observable mathematical teaching and learning practices. As part of this work, the authors are refining the tool to add or amplify student and teacher practices that support access to mathematical tasks and language. In alignment with this goal, this study was guided by the following research questions: (1) what observable teaching practices support students in making meaning of mathematical tasks and language, and (2) how might students engage in these making meaning practices?

Theoretical Orientation

Hawkins (2002) represents effective instruction by the relationships that exist between and among the vertices of the instructional triangle (see Figure 1a). In this triangle, the teacher builds a relationship with the student for purposes of understanding the student's relationship to the content, and then the teacher responds in ways that engage the student in thinking about and interacting with others and ideas that are intended to lead to a deeper understanding of the content. Lampert's (2003) expands on Hawkin's triangle by explaining, through examples from her own practice, how the problem space of teaching occurs along each of the arrows connecting the vertices of the triangle. Lampert adds a fourth arrow to the diagram to represent the relationship between the teacher and the arrow between students and content (see Figure 1b). Both Lampert (2003) and Cohen, Raudenbush, and Ball (2003) write explicitly about the need to consider how these triangular relationships

In: Sacristán, A.I., Cortés-Zavala, J.C. & Ruiz-Arias, P.M. (Eds.). (2020). *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Mexico. Cinvestav / AMIUTEM / PME-NA. https:/doi.org/10.51272/pmena.42.2020

function in the context of a teacher's work with individual students as well as in a classroom full of students. Cohen et al. (2003) make this explicit by adding a representation of multiple students interacting at the "student" vertex.

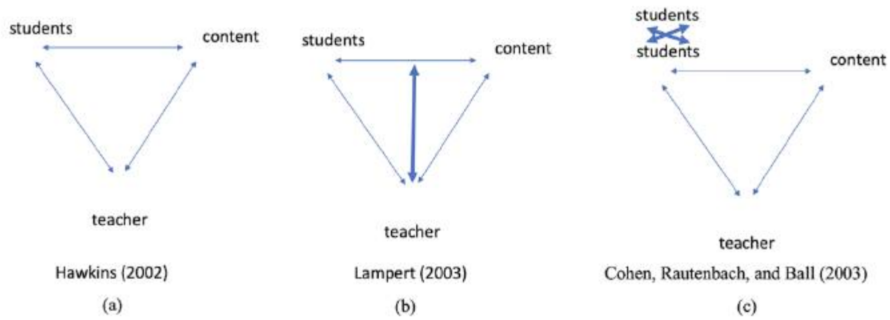

Figure 1. Three different representations of the student, teacher, content triangle.

The study team is working to delineate the complexities of these relationships in ways that make the actions both observable and learnable. By overlaying the triangle on the tool, one can see that the relationships are embedded (see Figure 2). Teachers initiate and enact catalytic teaching habits (CTH) and teaching routines (TR) to elicit student ideas and/or in response to what they understand students to be saying, doing, or understanding. These teacher actions are designed to prompt students to engage in habits of mind and interaction as a means of deepening their understanding of mathematical content. This study focuses on the project team's efforts to operationalize specific components of the tool (see highlighted text in Figure 2). What results is a smaller set of actions by and among teachers, students, and content that we hypothesize will support students in making meaning of tasks, contexts, and language.

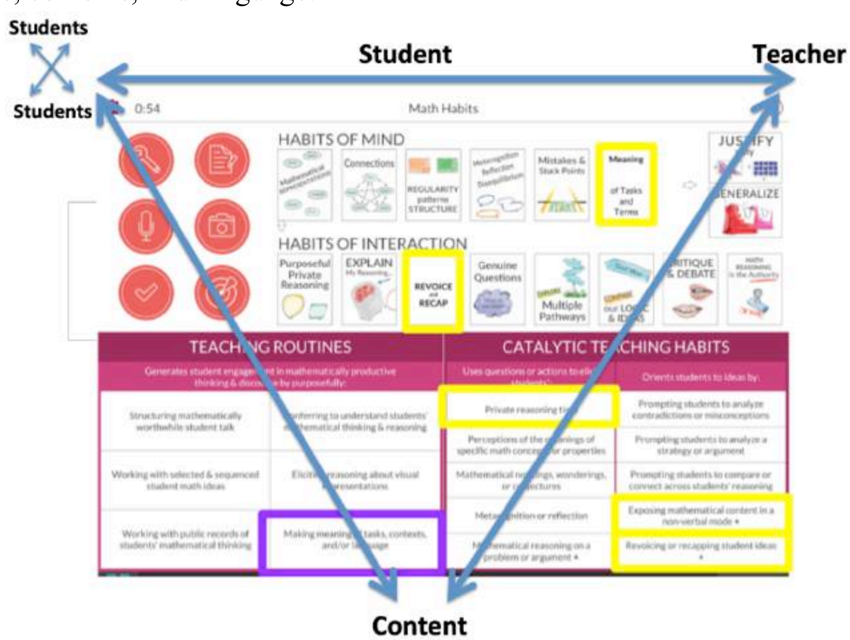

Figure 2. Teacher and student moves that support access to learning opportunities.

Methods

We drew upon two video banks of mathematics lessons spanning K-8 classrooms to identify teacher and student actions that supported students in making meaning of tasks and language. We initially developed a codebook that operationalized research-based practices (e.g., Ball, 1993; Jacobs &

Spangler, 2017; Nasir, & Cobb, 2006; Schoenfeld, 2011; Staples, 2007). Initial data analysis began with the development of a codebook with decision rules for the coding process and descriptions for each code. For example, we created distinct rules for coding TR stanzas and CTH stanzas with each stanza representing a discrete coded section of transcript data (Saldaña, 2013). TRs were defined as a collection of teacher-initiated moves that engaged students in prolonged mathematical discourse and/or productive thinking, while CTHs were defined as single teacher moves to elicit or focus student thinking. Additionally, student contributions were classified as a habit of mind (ways in which students engage with the mathematics) or habit of interaction (ways in which students engage with each other around the mathematics). These codes were then further refined through testing in classrooms and with video. Two researchers independently coded video transcripts, and then met to compare coding and resolve inconsistencies to reach interpretive convergence (Saldaña, 2013).

Findings

We present two excerpts that explicate the ways in which teachers might support students in making meaning of tasks and language. In the first transcript, the teacher implements a teaching routine to support students in making sense of a mathematical task before they start working on the task. The task states, "In a school gymnasium, 375 students have gathered for an assembly. The students are seated in 15 equal rows. How many students are seated in each row?"

Transcript	Code(s)
Teacher (reading the task aloud): In a school gymnasium, 375 students have gathered for an assembly. Okay, any questions there? Everybody knows what an assembly is? Although we haven't had many this year. We are going have one tomorrow. *Student*: We are? *Student*: Two *Teacher*: Two tomorrow. So we're going to be in an assembly tomorrow. Everybody gathers in the gym and we'll watch a show or something like that, presentation. …	**TR** (turns on): Making meaning of tasks, contexts, and/or language
Teacher: Okay, the students are seated in 15 equal rows. Any questions on rows? Rows are side to side. Columns are up and down. Anybody has been to a sporting event? *Student*: I have. *Teacher*: Usually your ticket says row so and so. So rows are like all the seats going across. Although we don't have rows in our assembly, some places do. How many students are seated in a row, in each row? Alright	**CTH**: Perceptions of the meanings of specific math concepts or properties **TR** (turns off): Making meaning of tasks, contexts, and/or language

Figure 3. Teacher practice analyzed with the meaning-making codes.

Here, the teacher uses the students' shared experiences of going to assemblies in their school and possibly attending sporting events to make meaning of the context of the task. Within this longer TR, the teacher then uses a CTH to define the specific mathematical concepts of rows and columns. Noticeably, the students were not observed actively contributing to making meaning of the task or language.

Conversely, in this second transcript the teacher and students both engage in making meaning of the task and language. This excerpt occurs after the students had been working through several story problems. The teacher implements the TR of making meaning of tasks and language after he notices that the wording of a particular task was confusing to some students. This task states, "How many periods of time, each ⅓ of an hour long, does a 8-hour period of time represent?"

Transcript	Code(s)
Teacher: So the question says how many period of times right? How many periods of time. Does it ask you how much time? Okay, it's asking how many periods of time. So what is that? It's kind of confusing right there. Periods of time. What is that mean periods of time?	**TR** (turns on): Making meaning of tasks, contexts, and/or language
Student: Periods of time means how many sections of time there is in certain amount of time. So, there is two periods of time in an hour that's half an hour long.	**HOM:** Meaning of Tasks & Terms
Teacher: So, who heard Gabby said about period of time?	**CTH:** Revoice and recap student ideas
Student: Basically, she said that each…okay…in this equation periods of time would be 8.	**HOM:** Meaning of Tasks & Terms **HOI:** Revoice & recap
Teacher: Eight, eight 1/3. That's you said. You haven't started middle school yet so you don't have period right? So period of time in that would be like you got a math class the first period. Second period you go to English, third period, fourth period okay. So that's periods of time. So we don't want to know that math is 60 minutes. We just call that first period or second period, third period. So periods of time. They are not looking for a time here. They are looking for how many periods of time. Does that make sense? So we are not going to have time here. We are going to have a number period. Like, how many periods do you have in middle school? I have 6 periods. How long are those periods? 50 minutes each or 60 minutes each, okay? That's different.	
Student: That's what I thought. It says how many, not how long.	**HOI:** Compare our logic and ideas
Teacher: Great! So, how long would be the time, right? ...Is it helpful for you guys in this conversation to know what [student] just said. He is helping clarify what we are talking about. It says how long are they so we want time. How many is how many periods are there. Different thinking on that.	**CTH:** Revoice and recap student ideas **TR** (turns off): Making meaning of tasks, contexts, and/or language

Figure 4. Student teacher interaction analyzed with the meaning-making codes.

During this TR, the teacher first elicits students' understandings of the concept of periods of time rather than merely defining a period of time. This leads to a student engaging in the meaning making HOM. The teacher then extends this with a CTH by asking other students to revoice the original student's ideas. The teacher adds to this definition by introducing the real world context of class periods in middle school. Finally, the clarification is made that a period of time refers to how many not how long, which leads to a student spontaneously engaging in a HOI to compare their thinking with the thinking being discussed. Taken together, these excerpts show how a teacher might implement a TR to support students in making meaning of task and language, and how the engagement of students during this TR may vary based on teacher responses.

Discussion

This work comes from a focus on how to support student access to mathematical content and discussions. We build upon Cohen and colleagues' (2003), Hawkin's (2002), and Lampert's (2003) conceptualization of the instructional triangle in order to support this goal. Through multiple rounds of theoretical and empirical exploration, we have identified teacher and student actions that appear to support students in making meaning of tasks and language. By explicitly naming these teacher and student actions, we hope to bridge the theory to practice divide by supporting teachers in learning about and implementing these practices in their own classrooms.

Acknowledgement

This research was supported by the National Science Foundation grant DRL-1055067, DRL-1223074, and DRL-1814114.

References

Aguirre, J. M., & Bunch, G. C. (2012). What's language got to do with it? Identifying language demands in mathematics instruction for English language learners. In S. Celedon-Pattichis & N. G. Ramirez (Eds.), Beyond Good Teaching: Advancing Mathematics Education for ELLs (pp. 183-194). Reston, VA: National Council of Teachers of Mathematics.

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *The Elementary School Journal*, 93(4), 373-397.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *Teachers College Record*, *110*(3), 608-645.

Chval, K. B., & Chávez, Ó. (2011). Designing math lessons for English language learners. *Mathematics Teaching in the Middle School*, *17*(5), 261-265.

Chval, K. B., Pinnow, R. J., & Thomas, A. (2015). Learning how to focus on language while teaching mathematics to English language learners: A case study of Courtney. *Mathematics Education Research Journal*, *27*(1).

Cohen, D. Raudenbush, S. Ball, D. (2003). Resources, instruction, and research. *Educational Evaluation and Policy Analysis, 25*, 119-142.

Hawkins, D. (2002). *The informed vision*. New York, NY: Algora Publishing.

Jacobs, V. R., & Spangler, D. A. (2017). Research on core practices in K-12 mathematics teaching. In J. Cai (Ed.), *Compendium for Research in Mathematics Education* (pp. 766-792). Reston, VA: National Council of Teachers of Mathematics.

Lampert, M. (2003). *Teaching problems and the problems of teaching*. New Haven, CT: Yale University Press.

Melhuish, K., & Thanheiser, E. (2017). Leveraging classroom observation to support teachers in increasing student reasoning. In L. West & M. Boston (Eds.). Annual perspectives in mathematics education 2017: Reflective and collaborative processes to improve mathematics teaching (pp. 183 – 200). Reston, VA: National Council of Teachers of Mathematics.

Nasir, N. I. S., & Cobb, P. (2006). Improving Access to Mathematics: Diversity and Equity in the Classroom. *Multicultural Education Series.* Teachers College Press. 1234 Amsterdam Avenue, New York, NY 10027.

National Council of Teachers of Mathematics. (2010 & 2014). *Principles and standards for school mathematics*. Reston, VA: Authors.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010; 2014). *Common core state standards for mathematics*. Washington, DC: Authors.

Saldaña, J. (2013). *The coding manual for qualitative researchers*. Los Angeles, CA: Sage Publications.

Schoenfeld, A. H. (2011). Noticing matters. A lot. Now what? In M. Sherin, V. Jacobs, & R. Philipp (Eds.), *Mathematics Teacher Noticing* (pp. 253-268). Routledge.

Staples, M. (2007). Supporting whole-class collaborative inquiry in a secondary mathematics classroom. *Cognition and Instruction*, *25*(2-3), 161-217.