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The work of positioning students and content in mathematics teaching

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Whereas other studies have applied positioning theory to analyses of teaching and learning mathematics, this paper takes a practice-based approach to unpack what positioning in mathematics teaching might entail. From analysis of a shared video where a teacher leads a mathematical discussion of the naming of a fraction on the number line, we unpack the work of continually balancing attention to the mathematical content with positioning of students in their relation to each other, to the teacher, and to the mathematical content.

Keywords: Mathematics teaching, work of teaching, positioning, intentionality.

Introduction

There is agreement in the field of mathematics education that a special knowledge of mathematics is required to teach well. Numerous studies have investigated the nature and composition of this knowledge, how it can be developed and improved, and whether and how it influences student learning and the quality of teaching (Hoover, Mosvold, Ball, & Lai, 2016). Studies have investigated how much and what mathematical knowledge teachers need to know, what teachers should know, or what knowledge mathematics teachers use in teaching. Ball (2017) suggests that our field should shift attention from the mathematics teachers need to know towards the entailments of the special mathematical work of teaching. She thereby calls for more attention to the knowing and doing that is embedded in teaching. To illustrate what this might look like, she analyzes a record of practice where the teacher (Ball) calls on an African American girl to name a fraction on the number line and then facilitates a mathematical discussion around this. From her analysis, Ball (2017) identifies, names, and unpacks the special mathematical work of teaching. One aspect of this work is attending to positioning of students and their mathematical identities. In the present paper, we analyze the same data to further unpack what positioning might entail in mathematics teaching.

Conceptual background

The idea of positioning is not new. To position someone is to place them in a certain location or disposition, or to make a certain location or disposition available. Positioning can refer to placement of objects, but it can also refer to the relation, rank or standing of one person relative to another (Oxford English Dictionary). The latter is in focus here. Positioning theory has developed from social psychology and linguistics; social psychology contributes with theories of roles and subjectivity, whereas the idea of a discursive production of selves comes from linguistics (Davies & Harré, 1990). Positioning theory has been applied in mathematics education for some years, but the importation of the theory from one field to another is not void of challenges (Herbel-Eisenmann,

Wagner, Johnson, Suh, & Figueras, 2015). We will examine some of these challenges in our concluding discussion.

In this paper, we have deliberately decided to start with analysis of practice rather than with theory, because we do not take it for granted that a theory developed to describe interpersonal relations in social psychology is relevant to studies of mathematics teaching. Our practice-based approach targets positioning in teaching, and three important assumptions underlie this approach. First, we consider teaching to be a professional practice. Describing a practice as professional implies some kind of consensus among professionals in terms of specifying the given practice. Currently, no such consensus exists, but we base our work on plausible conceptions of practice that practitioners might realistically agree about (Hoover, Mosvold, & Fauskanger, 2014). To this end, engaging in analysis of shared data of mathematics teaching is particularly promising. Second, we follow Ball (2017) when we describe teaching as “work”. This implies an emphasis on the effortful and dynamic nature of teaching. It also implies a shift in focus from characterizing teaching as actions of teachers to exploring the work that is to be done in teaching, and the entailments of this work. Third, we consider teaching to be instructional interactions between teacher and students around a particular content, within an environment (Cohen, Raudenbush, & Ball, 2003).

Data material and analytic approach

To explore positioning in mathematics teaching, we analyze one of the shared datasets that has been prepared for use in TWG19. This dataset shows a group of students (age 9–11), who have worked individually with a problem of naming fractions on a number line. Ball (2017) explains that the class has just shifted from naming fractions with area models to identifying fractions on the number line. The students have written their answers in their notebooks, and the teacher has been walking around, noticing the students’ range of ideas and explanations.

Based on our conception of teaching, our analysis is grounded in three basic questions: How does the teacher position particular students? How does the teacher position herself? How does the teacher position the mathematical content? When approaching these questions, we carefully consider instances of the teacher’s verbal as well as non-verbal communication that constitute evidence of positioning. We also ask about possible intentions behind making the identified positions available.

Analysis

As a first step in our analysis, we divided the video into thematic sequences. We identified six thematic sequences, and our analysis below is organized around these.

Sequence 1: Positioning Aniyah in the role of teacher

Teacher: (standing near the back of the room) Who would like to try to explain what you think the answer is? And show us your reasoning by coming up to the board? Who’d like to come up to the board and try to tell– And you know, it might not be right. That’s okay because we’re learning something new. I’d like someone to come up and sort of be the teacher and explain how you are thinking about it. Who’d like to try that this morning? (Several children raise their hands to

volunteer.) Okay, Aniyah? (Aniyah, a Black girl, gets up from her seat and walks to the whiteboard at the front of the classroom.)

Before selecting Aniyah to come up, the teacher provides some important signals to the class. First, she signals that she is more interested in their explanations and reasoning than in their answer. To emphasize this characterization of the available position, she states that “it might not be right,” and that this is okay. Furthermore, she explains that the reason why it is okay to present an incorrect answer is that they are now in the process of learning something new, and they are therefore not expected to know this already. She thereby indicates that students can successfully participate in the discussion without having the correct answer. Second, she describes the available role as one in which a student is going to “be the teacher.” When a student is invited to take the role of teacher, this implies that the teacher will temporarily step out of this role herself.

Several students volunteer to present on the board, but the teacher decides to call on Aniyah. We assume that this is an intentional act. The teacher might have decided that Aniyah’s solution is mathematically useful for the learning trajectory of the class. Another possibility is that the teacher keeps an eye out for students who rarely present at the board. Another possibility is that the choice is related to Aniyah’s racial identity. Aniyah is one of 22 African American students in class, and the teacher might attempt to disrupt systemic patterns of racism and inequity by calling on her — as indicated by Ball (2017). The first possible reason for calling on Aniyah refers to the mathematical quality of her reasoning, the second refers to her identity and role in the class, whereas the third relates to pressing issues in the environment outside the class. Balancing consideration for all three aspects is a challenge that is embedded in the mathematical work of teaching.

Sequence 2: Positioning students in relation to social norms of presenting mathematical ideas

Teacher: When someone’s presenting at the board, what should you be doing?

Students: Looking at them.

Teacher: Looking at that person—uh-huh.

Aniyah: (to the teacher) You want me to write it?

Teacher: (to Aniyah) You’re trying to mark what you think this number is and explain how you figured it out. (to class) Listen closely and see what you think about her reasoning and her answer. (Teacher moves to back of the classroom; Aniyah is in front at the whiteboard. Aniyah writes $\frac{1}{7}$ by the orange line).

In this second sequence, the teacher provides two additional signals about the norms of participation when someone is presenting at the board. The teacher first emphasizes that the students should always look at whoever is presenting. Understanding what others say in a discussion is necessary to productively contribute, and the other students have to pay careful attention to Aniyah’s presentation in order to understand her thinking. Paying attention without looking is hard. The students seem to know how to behave when someone presents, but the teacher’s question emphasizes this norm of participation. After telling Aniyah what to do, the teacher asks the class to listen and see what they think about Aniyah’s reasoning and answer. This explicit emphasis on the norms of participation signals a certain position that the students should take while interacting with

each other, but it also signals a positioning of the students in relation to the mathematical content. The students in class are directed to take a position of someone who listens carefully to make sure they understand Aniyah's reasoning, and they are asked to critically consider what they think about the reasoning as well as the answer. This position is different from a more traditional pattern in recitation, where the students answer the teacher's question and then receive feedback.

Sequence 3: Positioning Toni by praising her question

- Aniyah: I put one-seventh because there's—
- Toni: Did she say one-seventh? (An African American girl, sitting close to where Aniyah is standing, asks quietly, almost to herself)
- Aniyah: Yeah (Hearing her question, Aniyah turns toward her and nods). Because there's seven equal parts, like one, two, three, four, five, six, and then seven (Demonstrates using her fingers spread to measure the intervals to count the parts on the number line).
- Teacher: (still standing at the back, addresses the class) Before you agree or disagree, I want you to ask questions if there's something you don't understand about what she did. No agreeing and disagreeing. Just—all you can do right now is ask Aniyah questions. Who has a question for her? Okay, Toni, what's your question for her?
- Toni: Why did — (looks across at children opposite her and laughs, twisting her braid on top of her head)
- Teacher: (to Toni) Go ahead, it's your turn.
- Toni: (to Aniyah) Why did you pick one-seventh? (Toni giggles, twisting her braid.)
- Dante: (laughing across the room at Toni) You did not!
- Teacher: Let's listen to her answer now. (to Toni) That was a very good question. (to Aniyah) Can you show us again how you figured that— why you decided one-seventh?
- Aniyah: First, I thought it might be seven because there's seven equal parts.
- Teacher: Did you write one-seventh? I can't see very well from here.
- Aniyah: Uh-huh. Yes.

This is the crux of the episode, and there are at least three decisive moments that require careful balancing of considerations for the interactions between students and with the mathematical content.

First, there is the moment when Toni interrupts with her first question. With a low voice, she asks: "Did she say one-seventh?" The teacher could have decided to tell Toni to be quiet when someone else is presenting. Instead, she decides to wait. By doing that, the teacher gives Aniyah the necessary space to stay in the role of a teacher and respond to Toni's question. We notice how

Toni's question triggers Aniyah to continue her reasoning and show how the unit interval must be partitioned in equal parts by using her fingers spread to measure the intervals to count the parts on the number line.

Second, we notice how and when the teacher decides to interact. After Aniyah has given her explanation in response to Toni's first question, the teacher remains in the back of the classroom. This highlights her intention to remain in the role of facilitator, and thereby maintains the positioning of Aniyah as the teacher. The teacher positions the children to participate in the discussion, establishing an open atmosphere by guiding the children to pose clarifying questions and not agree or disagree in this initial phase of the discussion. She also limits the space of acceptable interactions to maintain the positioning of students in relation to the mathematical content that we described above. After having reminded the children about the social norms and rules, the teacher encourages Toni to pose her question to Aniyah. By allowing Toni to pose her question instead of rebuking her for interrupting Aniyah, the teacher allows Toni to take the role of a productive contributor in the mathematical discussion that is unfolding.

Third, it is interesting to notice how the teacher reacts to Toni's question. She could have commented on Toni's laughter and pointing, and thereby positioned her as disrupting the discussion. Instead, the teacher praises her question. This decision influences the ongoing positioning of Toni. Her question is seen as an important mathematical question, and the teacher's move emphasizes the importance of asking questions in mathematics, which represents an indirect positioning of the mathematics. By repeating and rephrasing it to Aniyah, the teacher also puts Aniyah in a position to further develop her explanation. The teacher's question — "Can you show us again?" — indicates that she wants Aniyah to relate her answer to the figure on the board. Aniyah repeats that there are seven equal parts, illustrating the distance from zero for a given point on the number line.

Sequence 4: Positioning of Lakeya and repositioning of Aniyah

Teacher: (The teacher nods affirmatively, and turns to the class) Okay, any more questions for Aniyah? In a moment, we're going to talk about what you think about her answer, but first, are there any more questions where you're not sure what she said, or you'd like to hear it again or something like that? Lakeya?

Lakeya: (looks back at the teacher at the back of the room) If you start at the—

Teacher: (gestures toward Aniyah) Talk to her, please.

Lakeya: Oh! (turns toward Aniyah) If you start at the zero, how did you get one seventh?

Aniyah: Well, I wasn't sure it was one-seventh, but first, I thought that the seven equal parts.

The teacher then refrains from evaluating Aniyah's explanation and thereby enables Aniyah to stay in the role of teacher. The teacher clarifies that they will soon discuss Aniyah's answer, but encourages more children to participate by posing clarifying questions. This comment indicates that understanding an argument is crucial in mathematics, and it thereby positions the mathematics in the discussion. This gives Lakeya an opportunity to ask a question and contribute to the discussion.

We notice how the positioning of Lakeya also constitutes a repositioning of Aniyah. By asking Lakeya to address Aniyah and not herself, the teacher affirms Aniyah's position as teacher in this context. The teacher gives Aniyah the responsibility and agency, and Aniyah gets the opportunity to explain her thinking again.

In this sequence, the teacher could have commented that Toni has just asked a similar question, or that Aniyah has already explained this. Instead, the teacher appears to notice a difference in the questions of Toni and Lakeya. Toni asked why Aniyah picked "one SEVENTH", which indicates an emphasis on the whole. Lakeya asked how she got "ONE seventh", indicating a focus on the parts. By deciding to let Aniyah respond, the teacher enables Lakeya to remain in the position of a productive contributor to the discussion, and she allows Aniyah to stay in the role as a teacher. Again, we see how the positioning of one student constitutes a repositioning of another, and we see how the teacher is challenged to balance attention to the positioning of students with attention to the content.

Sequence 5: Balancing positioning of Dante and Aniyah

Teacher: Okay, would some— You'd like to ask another question, Dante?

Dante: Yeah.

Teacher: Yes, what?

Dante: So, if it's at the zero, how did you know that if like if I took it and put it at the— Hold on. Which line is— What if it didn't like— What if the orange line wasn't there, and you had to put it where the one is? What if the orange line wasn't there? And how would you still know it was one-seventh to put it where the orange line is now?

Aniyah: (pauses) I don't know.

Teacher: (pauses) Okay. Does everyone understand how Aniyah was thinking?

Students: Yes.

Following Aniyah's response to Lakeya, Dante is given the opportunity to contribute. We observe that Dante relates Aniyah's answer to the orange line in the figure. His three repeated "What if"-statements indicate that Dante not only asks questions, but he also attempts to make sense of Aniyah's answer and extend their mathematical thinking about the mathematical content. Aniyah does not know how to answer Dante's questions. The teacher could have decided to praise Dante's contribution, but this might have been interpreted as a repositioning of Aniyah. When she decides not to comment, she gives both Dante and Aniyah the opportunity to remain in their positions as contributors to the discussion. When the teacher asks if they now understand Aniyah's thinking, this again represents positioning of the mathematics by emphasizing understanding of an argument, and by indicating that mathematics is the collective thinking of people. The supportive response from the class might be interpreted to indicate that Dante has made his classmates aware of the connection between Aniyah's answer one-seventh and the position on the number line. The response from the class might thus serve as an implicit positioning of Dante. The positioning of

Dante could also involve a repositioning of Aniyah, indicating that her idea and explanation could be a starting point for a more focused discussion that follows.

Sequence 6: Positioning of Aniyah by allowing her to stay or going out of the role as teacher

Teacher: Yes? Okay. (to Aniyah) You can sit down now. We're going to try to get people to comment. Do you want to take comments up there? Would you like to stand there and take the comments, or do you want to sit down and listen to the discussion? What would you prefer?

Aniyah: Sit down.

Teacher: Sit— You'd like to sit down? Okay.

In this last sequence, the teacher decides to not simply ask Aniyah to sit down. Instead, she gives Aniyah the choice to stay in her role as a teacher and take comments from the board, or to sit down and listen to the discussion. This choice might be seen as an implicit positioning of Aniyah.

Concluding discussion

Earlier in our paper, we mentioned how it might be challenging to import positioning theory for use in mathematics education (Herbel-Eisenmann et al., 2015), and how we deliberately decided to avoid using this theory and take a practice-based approach instead. We will now make two points that elaborate on some of these challenges and point to some potential contributions of our analysis. The first point relates to how positioning in mathematics teaching involves a careful balancing of multiple considerations regarding the interaction between students and teacher around a particular content. The second relates to the challenges of identifying positionings in analysis of teaching.

Whereas studies that use positioning theory in mathematics education tend to investigate how positionings might influence the development of students' mathematical identities (Herbel-Eisenmann et al., 2015), our analysis has identified various challenges that might be involved in the work of positioning students and the mathematical content. Our analysis indicates that positioning is tightly integrated with teaching. Teaching can be seen as interactions between teacher and students around a particular content with an ever-present influence with the environment (Cohen et al., 2003), and positioning in teaching is tightly connected with these instructional interactions. The challenges of positioning in mathematics teaching is thus rarely about singular and easily identifiable positionings. Positioning of one student tends to imply repositioning of another. The teacher is often challenged to make quick decisions that influence positioning of students, while simultaneously balancing this with careful attention to the mathematical content. In positioning the students — both in relation to each other, to the teacher, and to the mathematical content — the teacher has to balance multiple considerations. We suggest that the complexity of this balancing is at the heart of the work of teaching; this balancing defines the work that has to be done by the teacher. When the teacher invited Aniyah to present her thinking at the board, she had to navigate concerns for Aniyah and her developing mathematical identity, the development of other students, and to the class as a whole. At the same time, the teacher had to make decisions about her own position and how to lead the mathematical discussion without removing Aniyah from her position, and without placing any of the students in a negative position. The teacher also had to balance the

positioning of the students and herself in relation to the students while paying careful attention to the mathematical content being discussed, and she had to make decisions about how to position the students and herself in relation to the mathematical content. We observe how establishing and maintaining norms of participation played an important role here, and we suggest that establishing and maintaining norms is also a deliberate and challenging work that is tightly related to positioning in teaching.

In their discussion of how positioning theory has been used in mathematics education, Herbel-Eisenmann et al. (2015) also notice how positionings tend to be identified in a singular way. Although the focus of our study was not on identifying positionings, but rather to unpack some of the challenges of positioning in mathematics teaching, our analysis indicates that the identification of positionings in mathematics teaching is complex. As observers, we rarely know for sure how a teacher intended to position students in a particular moment of interaction, and we rarely know how students experienced being positioned. For instance, Aniyah might have experienced being positioned by the teacher in a way that differs from what the teacher's intentions were, and Dante, Lakeya, and Toni might have yet other interpretations of how Aniyah was positioned. In addition, the students are positioned (or experienced being positioned) in relation to the teacher, to each other, and to the mathematical content.

In her discussion of the special mathematical work of teaching, Ball (2017) identified positioning as an integral part of this work. In the present paper, we have further unpacked entailments of positioning in mathematics teaching, with a particular emphasis on the challenges of balancing positioning of students while at the same time retaining careful attention to the mathematical content. Although we have only analyzed one example of a slice of the mathematical work of teaching, we suggest that this balancing of positioning students in relation to the mathematical content is at the core of mathematics teaching. However, further studies are needed to investigate what this balancing might entail in different parts of the work of teaching, with different content, and at different grade levels. Further efforts are also needed to investigate ways of studying the intentionality and interpretation that is involved in this work.

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