Promoting Meaningful Conversations among Prospective Mathematics Teachers

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Abstract

Recent circumstances due to the COVID-19 pandemic and restrictions on entering public schools have created barriers for prospective teachers (PT) to gain valuable exposure to real classrooms. As a result, we have transitioned some teacher preparation from in person experiences to video case study analysis. Our research seeks to determine how this transition can foster development of critical teaching skills by infusing a model of powerful teaching with video of real classrooms. Our findings suggest that with online video case analysis PTs were able to advance their discursive conversations to strategic conversations by building on and transforming each other's articulation of proposed teacher moves. This model for PT preparation has the potential to foster more meaningful discourse among participants by providing a space to build on and refine their understanding of mathematics teaching.

Introduction

Researchers have advocated for providing prospective teachers (PTs) opportunities to interrogate the practice of teaching and learning in real contexts (e.g., Hiebert et al., 2007; Star & Strickland, 2008). Hiebert and colleagues (2007) proposed a framework for preparing teachers to learn from studying teaching, defining a collection of knowledge, skills, and dispositions that help PTs analyze teaching by actively making and testing conjectures regarding teaching. PTs should learn to assess if students achieve set learning goals and identify how instruction may have affected achievement. Part of determining if students are achieving set learning goals is to understand and interpret students' mathematical thinking, which can be improved through analyzing video (van Es & Sherin, 2008).

PTs have various opportunities to learn from studying teaching (e.g., field placement observations), but these may not allow PTs to experience the breadth of variance of teaching and learning in practice (van Es et al., 2014). Moreover, given the uncertainty of access to real classroom settings related to the COVID-19 pandemic, we need to provide alternatives. The use of video during teacher preparation provides teacher educators with the opportunity to expose PTs to a variety of teaching and learning scenarios. Additionally, using a viewing lens while analyzing instruction is critical because it moves PTs away from superficial classroom observations and allows them to direct their focus to specific characteristics of classrooms. This paper describes units within a secondary mathematics methods course in which PTs were given the opportunity to enhance their understanding of students' mathematical thinking by engaging in video analysis grounded in a particular teaching framework. We use

conversations and artifacts from class sessions to illustrate how these activities helped PTs engage in conversations about mathematics teaching and learning and hypothesize new ways to meet learning goals.

TRU Framework

Our research coupled video case study analysis with the Teaching for Robust Understanding (TRU) framework (Schoenfeld, 2014). The TRU framework characterizes five dimensions of high-quality mathematics instruction: (1) Content, (2) Cognitive Demand, (3) Equitable Access to Content, (4) Agency, Ownership, and Identity, and (5) Formative Assessment. The five dimensions of TRU have been empirically validated as necessary and sufficient to support high-quality instruction. Using the TRU framework guided PT discussions by providing a focus on aspects of powerful mathematics classrooms and to support them with a common language for discussing teaching and learning.

The Methods Course: Mathematics for Teaching

In their secondary mathematics methods course, PTs collectively engaged via Zoom video conferencing in rich discussions about videos of mathematics teaching and learning. This online methods course, the first of two offered, was developed to help PTs learn how to foster understanding of and commitment to teaching mathematics in a way that intentionally promotes student understanding. The instructor of the course used video case analysis during the last four weeks of the semester to promote student discourse around the pedagogical topics addressed over the semester with video cases aligned with the course goal of implementing tasks with high cognitive demand in both small and whole group class discussions. To combat the ways online courses might limit student participation, the instructor intentionally provided opportunities for PTs' voices to be heard throughout class meetings (e.g., inviting individuals to post their perspectives in an online community board prior to group work/discussion). Prior to online class meetings, the instructor assigned readings on the TRU framework, and students solved the mathematics tasks shown in the video. During the class meeting, the instructor engaged PTs in doing the mathematics and exploring the big mathematical ideas in the tasks. Aligning with the TRU framework, this activity was based on the discussion questions prompting PTs to anticipate student thinking and identify multiple solutions pathways. Following mathematical discussions, the PTs watched a video segment of students engaging in the same task. Of particular interest for the class were emerging understandings about how students consider specific mathematical ideas and how teaching moves aligned with the TRU dimensions could support student thinking. The video segments were supported by materials providing school type, school demographic information, and lesson details. Finally, each video included focus questions related to a particular TRU dimension, prompting students to analyze the student understanding from the video and to suggest teaching moves to make in the moment. After watching the video, the PTs were given time to individually respond to the reflection questions in the online community board. The instructor then facilitated small and whole group discussions about student thinking and possible teaching moves. The PTs utilized a TRU Framework tool to help consider where the

students were in relation to this dimension based on the video segment, and how a teacher could enhance a particular dimension with different teaching moves. The PTs used this structured reflection to develop critical skills, especially how to assess if lesson goals were being achieved by students, hypothesize why lessons did or did not work, and make conjectures about meaningful revisions to the lesson or teaching actions. Each PT was responsible for providing a proposed teaching move allowing the conversation to move away from just sharing their strategies to analyzing and critiquing their prognosis.

Methodology

This methods course consisted of the instructor and 16 PTs, 14 of whom agreed to participate in this research project. Data consisted of recordings from the whole group and breakout rooms, and discussion artifacts. These artifacts included: (1) shared digital boards that the students and the instructor could contribute to throughout each session, (2) Zoom chat conversations, and (3) digital versions of the mathematical tasks. To analyze the discussions, the research team used an internally developed iteration of frame analysis to code PT discourse (Leonard et al., 2021a). Student talk was segmented into diagnostic, prognostic, or motivational frames (Benford & Snow, 2000). A diagnosis details a problem of practice, a prognosis details a proposed solution, and a motivation provides justification for the prognosis. Each frame was coded according to a frame process (Benford & Snow, 2000). Two discursive frame processes, articulating and punctuating, occur when PTs present an initial idea or restate a previous idea without building upon the original thought. Strategic frames occur when there is a change from one frame to another as groups better understand the problem of practice. A bridging frame connects two or more unconnected frames. An amplifying frame clarifies a previous frame. An extending frame adds additional insight to support and strengthen a previous frame. A transforming frame generates new meaning based on previous frames. Contested frame processes, countering and disputing, are when disagreements arise that stem from philosophical differences relative to teaching and learning. After frames were coded, patterns in frame processes were analyzed to look for changes in the PTs engagement with video case analysis.

Findings

Frames during the First Video Case Analysis

The first video case focused on representing quadratic functions graphically. After naming the big mathematical ideas, PTs discussed student understanding through discursive frames. PTs articulated their understanding, but did not build on shared ideas. After watching the video together, PTs responded to the following prompt: “As a teacher, what questions might we ask or moves might we make that respond to students' thinking and help them to think more deeply about specific mathematical ideas”. They were provided with a tool where each PT was expected to identify an indicator they witnessed in the video and to document a proposed teaching move. The same pattern of student talk continued throughout this part of the discussion. Similarly to their previous conversation from this session, PTs engaged in three discursive, articulating

frames, with one amplifying frame. An example of their conversation is detailed in the transcript below when three PTs shared their suggested teaching moves.

> PT 6: Can you come up with an equation that makes a parabola be in only one quadrant? Well if I gave them time to try and come up with a quadratic equation that would make the parabola stay in one quadrant I feel they would be able to see that they can't.
>
> PT 8: [written comment from shared online document] Can you specify a domain or range that would keep a parabola in one quadrant?
>
> PT 7: I think there are kind of two directions, you can go with what PT 6 said, and then the other way would be what PT 8 said, can you specify a domain and range that would keep a parabola in one quadrant. I just like that because they started going in that direction, talking about domain and range so that could further help them. It seems they all know what a parabola is and most of them understand it will widen so then continuing with that discussion of domain and range to then investigate this question that they were focusing on.
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> PT 2: Pose the student's question to the whole class, as seen in the video. I think that was a very good question that the student asked, the misunderstanding they had and asking that question so the whole class can see if anybody else is having their misunderstanding and then additionally with people who are not having that misunderstanding, they can help explain the reality to the students who don't understand.

This excerpt illustrates how PTs were able to prognose in-the-moment teaching moves and how they were only able to begin to build on each other's prognoses. PT 6 articulated asking students to find an equation for the proposed parabola. On the shared digital document, PT 8 prognosed directing students' attention to the domain and range of a parabola. PT 7 acknowledged PT 6's response, but amplified PT 8's prognosis, adding clarification about why this would be an effective teaching move. PT 2 then articulated their prognosis, which aligned directly to the teaching move from the video. While PTs initially put their prognoses on a shared online document, they were only sharing their own ideas or other's similar to their own. Only during one frame was PT 7 able to amplify another PT's prognosis before the conversation returned to articulating frames.

Shift in Discussion Patterns

During the third video case analysis about evaluating statements about radicals, there appeared to be a shift in PT discussion patterns. Students in the video needed to determine and justify if a particular radical statement was sometimes true, always true, or never true. We identified four frames post-video watching in which the PTs engaged in both discursive and strategic frames. The excerpt provided below occurred after the PTs were prompted to organize their prognoses into categories and began to reflect on them as a whole group. Prognoses were organized into four similar groups: asking students to explain their thinking, asking students to explain each other's thinking, focusing students on the procedures of solving, and focusing students on the interpretation of their algebraic solutions.

PT 8: I definitely think the one where they ask them to explain their work because then they have to analyze exactly what they are doing, how did they reach that solution, and then it gets them to think more deeply about the math.
PT 6: I agree, but maybe I'm biased towards my own answer. I also think that it's important to get the other people in the groups to explain the reasoning also because if you're just asking the person who did it then they might know how, but if you're not asking the partners, in this case the partner is quiet, then they might not understand either, and then that's not really good. You know, they all have to understand.
PT 1: I kind of agree with that, like the bottom right one [interpretation of algebraic solution] kind of task orients the most, but like what PT 8 said the top right like, if you ask them to explain each step and then you can hear that they're uncertain about something, and you ask them to defend why it's right or wrong. That's going to go directly at the concept of the radicals because that's where they were confused at the end. If they can't prove themselves wrong, then they will see that they were doing it right. I think that task orients and keeps the cognitive demand high.
PT 5: I think that the top right area and the top, I mean the bottom right kind of almost connect with each other. You want them to understand everything they're doing up to the point where what the final answer means. That's what I'm thinking. So, like, we want them to understand what they're doing. I feel like when I was watching the video they were just like okay we need to find what x equals and then once they find out what x equals they're just like okay so x equals zero on the next problem. But they didn't write down or maybe they did, I don't know, write down, whether it was sometimes, never, always. So I feel it's the entire, that's why I'm saying those to connect with each other, because the top is talking about the process and the bottom is talking about the end results. And you want those two to connect with each other.

Here we see how PTs shifted their conversations from discursive to strategic frames. In the first frame, PT 8 articulated a prognosis to prompt a student to provide a more detailed explanation of their thinking. PT 6 extended this frame to include explanations from all students to ensure that group members have a shared understanding of the content. PT 1 provided a transforming frame, building on previous frames and referring to two different sets of prognoses. They suggested asking students to explain their thinking, but also indicated that the instructor be aware of the uncertainty in student explanations to further probe mathematical thinking by having students defend answers. In the final bridging frame, PT 5 analyzed the three previous frames and other prognoses on the shared board. They suggested the need for a connection between two prognoses to serve different purposes: assist the students' understanding of their misconceptions and have the connection to the larger mathematical idea of determining whether a statement is sometimes, always, or never true.

Conclusions

As the pandemic forced instructors to move methods courses to a remote format, there was concern about the impact it would have on PTs' ability to engage in meaningful conversations about mathematics teaching and learning.

Our research team's previous work found that using video case studies can support the development of necessary teaching skills for entering the profession (Leonard et al., 2021b). As we transitioned the delivery of video case studies analysis to a virtual classroom, we provided additional support for students to document their ideas through the use of shared online documents. This space allowed PTs to all share initial thoughts and use those ideas as a building block to foster more meaningful conversations. Previously, during in-person courses, the PTs engaged in these conversations as a whole group, which could cause some PTs to not engage. By creating a space for all to engage in the conversation and allowing time for PTs to process each other's ideas, they were able to, over time, have more meaningful conversations about mathematics teaching and learning as evidenced by their transition from discursive to strategic frames. The tools used in this virtual classroom can be used in all formats to assist PTs to build off of and make connections among each other's ideas to refine their understanding of mathematics teaching and learning.

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