Preparing Pre-service Teachers to Build on Student Thinking

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Background

Research has documented the benefits of instruction that meaningfully incorporates student thinking. However, teachers often do not know how to effectively respond to student thinking that arises during instruction. Therefore, we are interested in supporting preservice teachers’ development of the practice of productively using student thinking. An important first step in productive use of student thinking is identifying the specific mathematical ideas, if any, that underlie an instance of student thinking. This step is important because identifying the underlying specific mathematical idea(s) allows the teacher to determine if an instance of student thinking is worth pursuing. A concise statement of the specific mathematical idea that students could learn from the instance of student thinking is what we call the Mathematical Point. Instances of student thinking in mathematics thinking made public during whole class discussions, if made the object of discussion, have the potential to foster learners’ understanding of important mathematical ideas—these instances of student thinking are called MOSTs (see, e.g., Martin & Van Zoest, 2015). Teachers are more likely to identify Mathematical Points in MOSTs that occur in their classroom when they know what important ideas students need to learn. Charles (2005) refers to these important ideas as mathematical understandings. When mathematical understandings are reflected in student thinking, they become Mathematical Points.

Research Question

What happens when prospective secondary school teachers are engaged in activities designed to focus them on Mathematical Points that student thinking can be used to build toward?

Project Design

While teaching a secondary mathematics methods course, we created two activities to support preservice teachers in developing the ability to identify Mathematical Points in instances of student thinking. All the class sessions where these activities took place were video recorded and transcribed. We collected all work done by the preservice teachers throughout the course related to Mathematical Points. This student work included written statements in field experience reports where preservice teachers spontaneously discussed Mathematical Points. Finally, an essay question on the final exam was given to assess the preservice teacher’s understanding of Mathematical Points and the preservice teachers’ answers were collected. The transcriptions of class discussions and pieces of student work are the focus of our analysis.

Activity 1: Card Sort

The first activity was a card sort of 26 statements that the preservice teachers categorized on the basis of whether the statement on the card was a Mathematical Point or not. Each card that qualified as an example of a Mathematical Point corresponded to a card with a similar idea that did not qualify as a Mathematical Point.

Activity 2: Mathematical Points in Student Work

We provided the preservice teachers with instances of student thinking and a set of possible Mathematical Points. The preservice teachers were asked to identify the Mathematical Point that the student thinking could be used to build toward. Five pieces of student work and seven Mathematical Point possibilities were provided (two of which were distractors). The purpose of this activity was to develop preservice teachers’ ability to identify the Mathematical Point closest to the student thinking.

Results 1

After the card sort activity the preservice teachers were able to:

- identify examples and non-examples of Mathematical Points
- articulate a Mathematical Point for a mathematical idea

Evidence:

Abigail said: “Well I think [to understand the proportional relationship from a graph] would be a non-point.”

To fix the “non-point” above, Abigail suggested: “Something like proportional relationship represented in a graph must pass through the origin.”

However, the preservice teachers found it challenging to identify Mathematical Points from instances of students thinking. This difficulty led to the creation of the second activity.

Results 2

As a result of the two activities we were able to address the following issues with the preservice teachers:

- Mathematical Points must be accurate, but the student thinking may not be.
- Mathematical Points must be “close to the trunk.” We consider the student mathematical thinking as the trunk of a tree, with mathematical ideas related to the student thinking the branches. The mathematical idea (branch) closest to the student mathematical thinking (trunk) is the Mathematical Point for that particular instance of student thinking.
- The student does not have to make the Mathematical Point.
- The Mathematical Point is what the teacher has in their head, not something they would tell the students. From the class conversations and assessments related to Mathematical Point there was evidence that the preservice teachers developed:

- a sense of the importance of Mathematical Points in productively using student thinking;
- an ability to articulate Mathematical Points underlying student thinking.

Evidence:

Ted: “[Mathematical points] allow you to use where the student's understanding currently is in a way to move them toward the understanding of a mathematical idea you want them to be at. This allows you to build off student ideas yourself or preferably through student discussions in such a way that raises everyone's understanding of the mathematics being discussed.”

Isabelle: “It is important to have mathematical points in mind because this focuses and guides the lesson towards highlighting important math concepts. It requires understanding of student thinking and interpreting it in order to probe student thinking in the direction toward the point.”

Conclusion

Throughout the process of creating and implementing these activities, we learned that articulating Mathematical Points is a difficult process. However the evidence suggests that identifying and articulating Mathematical Points is an important teaching practice for preservice teachers to begin to develop in order to learn how to productively use student thinking. Based on our observations, the two activities presented here have potential to support preservice teachers’ abilities to identify and articulate Mathematical Points underlying student thinking. However, these are not the only abilities needed to productively use student thinking. Some next steps involve supporting preservice teachers’ abilities to decide which student thinking is worth pursuing and what actions can be taken to productively use the thinking that is worth pursuing.

References


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