UNCOVERING TEACHERS' GOALS, ORIENTATIONS, AND RESOURCES RELATED TO THE PRACTICE OF USING STUDENT THINKING

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Improving teachers' practice of using student mathematical thinking requires an understanding of why teachers respond to student thinking as they do; that is, an understanding of the goals, orientations and resources (Schoenfeld, 2011) that underlie their enactment of this practice. We describe a scenario-based interview tool developed to prompt teachers to discuss their decisions and rationales related to using student thinking. We examine cases of two individual teachers to illustrate how the tool contributes to (1) inferring individual teachers' goals, orientations and resources and (2) differentiating among teachers' uses of student thinking.

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Researchers and teacher educators need to better understand teachers' reasoning about the practice of using student mathematical thinking in order to support teachers in enhancing that practice. In previous work (e.g., Peterson & Leatham, 2009; Stockero & Van Zoest, 2013), we have used classroom observations and recordings of instruction to understand teachers' responses to student ideas; however, these methodologies have been insufficient in two important ways. First, we have found that using video of instruction to analyze teachers' responses to student thinking does not provide sufficient data to make certain inferences, particularly when teachers do not respond to students' ideas—we have no way of knowing whether the lack of response was deliberate, or whether the teacher did not notice the importance of an idea. Second, we have found it difficult to make comparisons among the practices of teachers who are teaching different content, in different contexts, with different student responses, and thus, have different opportunities to use student ideas. To provide a mechanism for better understanding how different teachers respond to student mathematical thinking in similar contexts, we developed a scenario-based interview (Scenario Interview) as a tool to further understand teachers' use of student thinking. Here, we describe the interview tool and illustrate the type of information it avails us in regard to teachers' goals, orientations, and resources (GOR) in the context of using student thinking.

The Instrument

Schoenfeld's (2011) theory of goal-oriented decision making describes teachers' decisions as being shaped by their GOR. A goal is "something that an individual wants to achieve, even if simply in the service of other goals" (p. 20). Goals can be short- or long-term, and may relate to the learning of specific content, to broader outcomes for students or to teacher actions. Goals may or may not be conscious to the teacher, meaning that one cannot simply ask teachers to state all of their goals for their students and their classroom. Orientations are defined to include teachers' "dispositions, beliefs, values, tastes and preferences" (p. 29) of which, like goals and resources, teachers may not be explicitly aware (Leatham, 2006). Resources include everything a teacher could access to support instruction. They include not only physical materials, but also teachers' knowledge (of, for example, things such as mathematics content, teaching strategies, and typical student conceptions). Schoenfeld

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(2011) stipulated that, together, teachers' GOR drive their behavior in the classroom. Understanding GOR in the context of using student thinking is critical to understanding why teachers engage with student mathematical thinking as they do and what might help them further develop this teaching practice. The Scenario Interview was created to provide insight into how a teacher thinks about attending to student thinking during instruction and to infer teachers' GOR in the context of using student thinking.

Throughout the Scenario Interview the teacher is presented with statements from eight individual students—four each from algebra and geometry contexts—that represent a range of thinking, including statements of answers, explanations of solution processes, a suggestion to modify a problem context, and unclear thinking. The interviewee is situated as a classroom teacher and asked to describe what they might do next were the student statement to occur in their mathematics classroom. Although normally a classroom teacher would know details of the context of the situation in which the student thinking occurred (e.g., the task that students are working on, what prompted the student statement, etc.), the Scenario Interview initially does not reveal to the interviewee any contextual information. Rather, after being presented with a student statement, the teacher is given an opportunity to ask questions about the context, which offers insight into possible GOR that the teacher relies on to make decisions. The interviewee is then given five more opportunities to reveal their GOR as they are asked to: (1) describe what they would do immediately after the student's statement was made, (2) explain why they would respond in that way, (3) articulate assumptions they were making that informed their decision, (4) explain their reason for wanting to know the contextual information they asked about, and (5) describe how their response may have been different had they known additional contextual information.

Usefulness of the Instrument

Here we describe two teachers who were chosen to highlight different GOR that might affect teachers' decision making with respect to using student thinking. Although the interviews revealed several GOR for each teacher, we limit our discussion to just one main goal for each (along with one related orientation and resource) to illustrate how the Scenario Interview allows us to infer the reasoning that underlies each teacher's use of student thinking. After discussing each teacher individually, we look across the teachers to highlight differences in their GOR that the interview revealed and discuss how this knowledge might inform the work of researchers and teacher educators.

Ms. Shaw

Ms. Shaw's main *goal* for having students share their thinking is to engage them in making sense of the mathematics behind the thinking. She wants to engage the sharing student in sense making through questions that highlight important mathematical ideas in the thinking, such as, "What are you assuming when you're giving me 4 pi? How did you come up with that band as 4 pi?" and "Why are you using [2] as your radius?" She also wants to engage the whole class in making sense of student ideas. For example, in a situation where a student modified a problem, she proposed turning that modification to the class and asking questions such as, "What would my table look like [in this new situation]? What would my graph look like? How does [this modification] change those two representations?"

One of Ms. Shaw's *orientations*—that an important part of student learning is providing students ample opportunity to think about mathematical ideas—helps her achieve her main goal by ensuring the presence of plenty of student thinking to ground the class discussion. She values providing students individual "think time" before hearing others' ideas about a problem, as well as time to individually "process" ideas that surface during whole-class discussion. Furthermore, Ms. Shaw believes in providing opportunities for students to collectively think about and, when appropriate,

compare ideas during whole class discussion: "I want the class to look at the two methods… tell me what they're doing differently. What is similar?"

Consistent with the above goal and orientation, Ms. Shaw considers student mathematical thinking a *resource* for making instructional decisions and helping students make sense of the mathematics in a lesson. She thinks through what students might be able to contribute, and wonders "Can they talk through it?... Is someone going to bring that up for me?" For Ms. Shaw, having a student clarify their ideas provides a means to help all students make sense of the mathematics. For example, she sees student responses to her probing questions as opportunities for all students to "start to see" the compelling mathematics behind student thinking.

Mr. Mead

Mr. Mead's main *goal* for having students share their thinking is to position students as thinkers. He wants students to elaborate on their thinking, both "to see what they think about [a] situation" and to encourage that thinking by "grab[bing] onto that thinking". Although he sometimes has his own ideas about what students might be thinking, he still wants to "dig into" student ideas to "try to figure out what… the student [is] actually thinking," thus positioning students as mathematical thinkers.

Not surprisingly, Mr. Mead's *orientations* include the belief that students can learn mathematics through exploration—"developing their understanding through [a] problem." He is comfortable leaving ideas that surface early in a lesson unresolved, knowing that students will have opportunities to think about them further during the lesson: "If this was a launch of the lesson then… I would say, 'Ah, okay, that's interesting Chris. So how did you get that?'… and maybe get a couple others. If I didn't get any other ideas, then I would just go ahead with the lesson. I wouldn't even address the fact that Chris is wrong at this point."

Mr. Mead uses student thinking as a *resource* to develop the mathematical ideas in a lesson and to tie ideas together. For example, after two students shared different methods of solving a problem, he suggested that he would position the lesson as "more of a verification of what [they] did for us today, so… let's verify whether… the methods… are correct or not, and that would give me something to go back to at the end as well." In another instance, he positions a student idea as a resource for "helping me [and] the students with this context—understand this," because "it's… just a little bit ahead of where we wanted to go at that point, but it seems like it's great to take an idea like that and to run with it." Viewing the student's idea as an opportunity to help the class increase their mathematical understanding, even though it is "a little bit ahead" helps Mr. Mead meet his goal of positioning students as mathematical thinkers.

Discussion and Conclusion

The Scenario Interview helped us to infer subtle differences in teachers' GOR. For example, Ms. Shaw and Mr. Mead both viewed student thinking as a resource for helping students develop an understanding of the mathematics in the lesson. Their main goals for having students share their ideas, however, are slightly different. Ms. Shaw's primary goal is to engage students in making sense of the mathematics behind the thinking that is shared—a content related goal. By contrast, Mr. Mead's primary goal is to position students as mathematical thinkers—a goal more closely related to identity formation. Ms. Shaw's belief in the importance of providing students ample opportunity to think about mathematical ideas individually or as a group supports her goal of using student thinking as a vehicle for students to make sense of the content. Mr. Mead's orientation that students can learn through mathematical exploration positions them as the "doers" of mathematics, and thus supports the development of their mathematical identity. These two cases illuminate the value of the Scenario Interview for inferring GOR at a level that one can make distinctions among teachers—even those who use student thinking in similar ways. If we observed Ms. Shaw and Mr. Mead questioning

students about their ideas, we might conclude that they had the same goals and orientations related to using student thinking as a resource.

However, the Scenario Interview revealed subtly different purposes for similar teacher actions. Because GOR are often implicitly held, they cannot be accessed merely through observation or direct questioning (Leatham, 2006). The Scenario Interview appears to be an effective mechanism for prompting teachers to discuss teaching practice in ways that contributes to revealing their GOR. For example, requiring teachers to ask for the contextual information they feel is relevant for deciding how to respond to an instance of student thinking provides information about what resources they draw on and what they value in making decisions.

Prompting teachers to talk about the same varied collection of instances of student thinking provides multiple opportunities to infer their GOR, allowing us to develop themes that characterize each teacher's GOR while also providing the similar context needed to identify important differences among teachers in terms of the GOR that underlie the practice of using student thinking. The Scenario Interview appears to be a valuable addition to our methods of collecting data that allow us to confidently infer teachers' GOR and thus better understand teachers' practice of using student mathematical thinking. Understanding the current state of this practice for particular teachers has the potential to support researchers and teacher educators in designing learning opportunities to enhance this teaching practice that are responsive to teachers' current thinking.

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References

Leatham, K. R. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education, 9*, 91-102. doi: 10.1007/s10857-006-9006-8

Peterson, B. E., & Leatham, K. R. (2009). Learning to use students' mathematical thinking to orchestrate a class discussion. In L. Knott (Ed.), *The role of mathematics discourse in producing leaders of discourse* (pp. 99-128). Charlotte, NC: Information Age Publishing.

Schoenfeld, A. H. (2011). *How we think: A theory of goal-oriented decision making and its educational applications*. New York, NY: Routledge.

Stockero, S. L., & Van Zoest, L. R. (2013). Characterizing pivotal teaching moments in beginning mathematics teachers' practice. *Journal of Mathematics Teacher Education, 16*, 125-147.