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Learning to notice important student mathematical thinking in complex classroom interactions

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HIGHLIGHTS

- Teacher noticing skills can be developed early in a teacher education program.
- It is possible to develop noticing skills using unedited, full-length classroom video.
- Limiting the focus of artifacts used to support noticing may be unnecessary.
- Using a framework to scaffold noticing may result in more refined noticing.

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ABSTRACT

Noticing students' mathematical thinking is a key element of effective instruction, but novice teachers do not naturally engage in this practice. Prospective secondary school mathematics teachers were engaged in an intervention grounded in analysis of minimally edited video from local secondary school mathematics classrooms; the goal was to support their ability to notice important student thinking within the complexity of instruction. Evidence of participants' learning in five iterations of the intervention is discussed, including their focus on student mathematical thinking, their ability to discuss the mathematics in that thinking, and their ability to notice particular high-leverage instances of student thinking.

1. Introduction

A key distinction between novice and expert teachers is their ability to notice what is important in complex classroom situations (Berliner, 2001). One particularly important focus of teacher noticing is student mathematical thinking, since teachers' use of student ideas has been identified as an important element of effective mathematics instruction (e.g., Anthony, Hunter, & Hunter, 2015; Jaworski, 1994; National Council of Teachers of Mathematics (NCTM), 2014) and has been linked to increased student learning (e.g., Fennema et al., 1996). Novice teachers, however, do not naturally focus their attention on making sense of student ideas (Jacobs, Lamb, & Philipp, 2010); rather, they tend to focus on other aspects of the classroom such as management (Star & Strickland, 2008) and teacher actions (Santagata, Zannoni, & Stigler, 2007), often failing to make distinctions among the pedagogical value of these different events (Sherin & van Es, 2005). Fortunately, teachers' ability to notice student mathematical thinking is a skill that can be learned (e.g., Jacobs et al., 2010; Sherin & van Es, 2005) and has thus become a focus in many teacher preparation programs. Incorporating learning-to-notice activities in structured settings is part of a growing movement to provide "opportunities to practice elements of interactive teaching in settings of reduced complexity" (Grossman & McDonald, 2008, p. 190).

Prospective teacher (PT) noticing interventions have typically taken place late in teacher preparation programs, during

Abbreviations: PT, prospective teacher; MOST, Mathematically Significant Pedagogical Opportunity to Build on Student Thinking; PTM, Pivotal Teaching Moment.

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mathematics pedagogy courses or the practicum semester (Mitchell & Marin, 2015; Roth McDuffie et al., 2014; Santagata et al., 2007; Schack et al., 2013). It is worth considering whether noticing skills can be developed at the beginning of a teacher education program, however, because noticing student ideas is a key component of teaching expertise and foundational to student-centered instruction (Sherin, Jacobs, & Philipp, 2011). Developing such skills early on could support what Franke and Kazemi (2001) have called *generative growth*—the ability to build on current understanding to generate new knowledge—during later phases of the program.

School-based field experiences that take place early in a teacher education program are one promising context for developing noticing skills because they provide a venue for real time observation and interaction with students in a practice-based setting. Focusing on a construct such as noticing also has the potential to address some of the criticisms of such experiences, including that they often have ill-defined goals that are not communicated to school-based mentors (Leatham & Peterson, 2010), lack adequate support to allow PTs to engage in meaningful observation of teaching and learning (Masingila & Doerr, 2002), and support what is currently being done in classrooms rather than helping PTs consider new possibilities for instruction (Philipp et al., 2007). In this work, we re-conceptualized an early field experience as a context to develop PTs' abilities to notice student mathematical thinking. Doing so, we conjectured, would articulate a clear goal for learning, provide a structure to support productive observation, and lay a foundation for student-centered instruction.

The intervention in this study was designed to promote PTs' noticing of high-leverage instances of student thinking that could be used by a teacher to support students' understanding of important mathematics. Key elements of the intervention included use of whole-class, teacher-perspective video; engaging PTs in fine-grained video analysis; and substantial involvement of a teacher educator to help PTs make sense of what they observed in the classroom. In this paper, we focus on understanding the effects of this learning-to-notice intervention by examining the question: In what ways does prospective teacher noticing of high-leverage instances of student mathematical thinking change as a result of a noticing intervention during an early field experience course?

2. Connections to the literature

In recent years, a growing body of research has emerged around the construct of *teacher noticing* (van Es & Sherin, 2002). This construct's importance stems from its centrality to student-centered mathematics instruction; in short, teachers cannot intentionally act upon student ideas they do not notice (Sherin et al., 2011). Although noticing research has focused on teachers' attention to a range of features of classroom instruction, we limit our discussion to studies that have a focus consistent with our own work—noticing student mathematical thinking. We discuss how such noticing has been studied, how this skill has been developed with PTs, and the emerging body of literature related to the use of frameworks to scaffold teacher noticing.

2.1. Ways of studying teacher noticing

Studies of teacher noticing have varied both in the medium used and the mathematical focus. A common means of studying noticing is engaging teachers in analysis of student written work to document what they notice about students' mathematical thinking. For example, Fernández, Llinares, and Valls (2013) used student work to document what prospective primary teachers noticed relative to students' ability to reason proportionally, while Haltiwanger and Simpson (2014) used this medium to document what prospective secondary teachers noticed about students' thinking related to extending a pattern. Others have used short video excerpts of diagnostic interviews (Schack et al., 2013) or classroom instruction (Walkoe, 2015); these interventions were related to noticing early arithmetic reasoning and algebraic reasoning, respectively. Jacobs et al. (2010) used both student written work and a short video clip to assess teachers' highest level of noticing related to students' problem solving with whole-number operations when they interacted with either medium. In all of these studies, the student thinking available to notice was narrowed in some way, either through the medium or the mathematical focus. Constraining what is available to notice has advantages, but it also has limitations. Constraining noticing to a specific mathematical topic allows for assessment against specific mathematical criteria (e.g., noticing stages of learning, common strategies), but requires that frameworks be developed for each mathematical topic (Fernández et al., 2013; Walkoe, 2015). Constraining noticing by narrowing the medium—using written work or a short video clip—makes interventions more manageable (Schack et al., 2013), but is very different from the noticing that takes place during complex classroom interactions. In short, it is not clear whether skills developed in a narrowed noticing context will transfer to noticing in the classroom.

Video excerpts with a range of mathematical foci have been used to both develop and document noticing in a way that more closely approximates the noticing that teachers engage with in a classroom. Such studies have typically utilized short researcher-selected video clips, either from available sources (Roth McDuffie et al., 2014) or from participants' own classrooms (Sherin & van Es, 2005; van Es, 2011). Some recent studies have examined teacher noticing using media that encapsulates the full complexity of classrooms. For example, Barnhart and van Es (2015) assessed the outcomes of a video-based course focused on analyzing instruction by examining what prospective science teachers noticed in their own student teaching video. Mitchell and Marin (2015) had students analyze 20-min segments of their own student teaching videos, while Vondrová and Žalská (2015) considered prospective mathematics teachers' noticing using videos from the TIMSS 1999 Video Study. Because the content and focus of the videos in these studies varied, they required different analysis techniques. In such studies, it is common for researchers to assess noticing using frameworks that characterize aspects of noticing such as what (different actors and topics) and how (level of description or analysis) teachers notice (e.g., van Es & Sherin, 2008). A similar analysis of components of teacher noticing was used in the current study that incorporated full-length classroom video, but additional analysis techniques were also used to determine whether the participants were noticing particular types of instances that transcend specific mathematics content or courses—those that have significant potential to support students' mathematical learning.

2.2. Prospective teacher noticing interventions

Some researchers have tried to promote PT noticing through targeted interventions. Those designed to focus on *professional noticing of children's mathematical thinking* (Jacobs et al., 2010) have mainly developed noticing skills through analysis of short video excerpts, typically during a mathematics pedagogy course. Schack et al.'s (2013) intervention engaged PTs with video clips of diagnostic interviews with children over five class periods to develop their ability to notice children's thinking about early numeracy. Roth McDuffie et al. (2014) engaged PTs in analysis of four to five video clips to develop noticing through four lenses: teaching, learning, tasks, and power and participation; Walkoe (2015)