Responsive Teaching of Expert Elementary Mathematics Teachers

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Effective mathematics instruction involves teachers engaging with and taking up student ideas and then deciding how to respond in ways that develop that thinking. There are various constructs used by mathematics educators to refer to teaching that centers student thinking, including cognitively guided instruction, formative assessment focused on disciplinary thinking, professional noticing of children's mathematical thinking, and responsive teaching.

approximations of practice professional noticing teacher reasoning

1. Introduction

Effective mathematics instruction involves teachers engaging with and taking up student ideas and then deciding how to respond in ways that develop that thinking [1][2][3][4]. There are various constructs used by mathematics educators to refer to teaching that centers student thinking, including cognitively guided instruction [5], formative assessment focused on disciplinary thinking [6], professional noticing of children's mathematical thinking [7], and responsive teaching [2][8][9]. While these practices are nuanced, they all require a dynamic interplay between students and teachers that is difficult to facilitate even for expert teachers [8][10].

In this research, researchers draw on research related to professional noticing of children's mathematical thinking [7] and responsive teaching [2][8][9] to create and study teachers engaged in a practice space that simulates a teacher sitting down after class is over to examine students' written work. To prepare for their participation in this practice space, the teachers were asked to bring pieces of written work from their classrooms. They were then prompted to attend to, interpret, and decide how to respond to the student thinking contained in the piece of written work. When asked to do this, teachers first attended to and interpreted student thinking directly on the piece of written work; they often then made sense of the student thinking by reasoning in ways removed from the written work and prior to deciding how to respond.

2. Responsive Teaching and the Instructional Reasoning of Expert Elementary Mathematics Teachers

2.1. Teacher Cognition: Pedagogical and Instructional Reasoning

Teacher cognition is complex. It involves the processes teachers work through as they make instructional decisions. This invisible cognitive work is often referred to as pedagogical reasoning. Loughlin et al. [11] described

pedagogical reasoning as “the thinking that underpins informed professional practice” (p. 4). According to Loughlin et al. [12], understanding how pedagogical reasoning develops and the way it influences practice is critical for teacher development. Building on the concept of pedagogical reasoning, Dyer and Sherin [2] introduce the term instructional reasoning to describe the additional thinking that goes beyond describing what a student said or did, to making interpretations of student mathematical thinking that “…help teachers make sense of student thinking in ways that are instructionally-relevant” (p. 70). For example, teachers may connect student thinking to broad disciplinary thinking [13], synthesize and compare across interpretations of student thinking [14], hypothesize links between classroom experiences and interpretations of student thinking, or consider individual student characteristics [15]. While many of the ways that teachers might engage in instructional reasoning are known, more research is needed on how teachers engage in instructional reasoning in ways that align with responsive teaching.

2.2. Responsive Teaching

Responsive teaching is grounded in a sociocultural theory in which learning is viewed as an active process situated in authentic activities and discourses of communities of practice [16][17][18]. It is both a teaching stance and a practice enacted in classroom settings in which teachers recognize the importance of using the substance of student thinking to guide instructional decisions [19]. To engage in this kind of learning, teachers must view students as active learners with prior knowledge developed in and outside the classroom and draw on that knowledge to develop student ideas. For example, responsive teachers ask questions in a way that draws out student emergent ideas and helps students connect and build off each other’s ideas during classroom instruction [18] or encourages students to provide alternative explanations of natural phenomena [20].

Dyer and Sherin [2] identified three responsive teaching practices during classroom discussions that involve: (1) a substantive probe of student ideas; (2) an invitation for student comment; and (3) a teacher uptake of student ideas. To characterize the instructional reasoning that led to responsive teaching practices, Dyer and Sherin [2] identified video clips of whole class instruction that captured these practices. Then, they analyzed the video clips alongside the interview transcripts to identify the instructional reasoning just prior to an instance of responsive teaching. Dyer and Sherin [2] were able to identify three types of instructional reasoning that lead to responsive teaching. These involve a teacher (a) connecting specific moments of student thinking across different points in time and situated student thinking in relation to two or more students; (b) considering the relationship between student thinking and the structure of a mathematical task; and (c) developing tests of student thinking. In this research, researchers identified instructional reasoning that leads to responsive teaching practices in a different context. Rather than using teacher-selected video clips, researchers used teacher-selected pieces of student work. In addition, researchers drew on literature related to the design of approximations of practices in which responsive teaching practices can be rehearsed in a setting of reduced complexity [8][21][22].

2.3. Modeling Responsive Teaching

To capture how expert teachers make instructional decisions that are responsive to student thinking, there is a growing movement toward practice-based teacher education. Practice-based teacher education is a form of

teacher education that focuses using scaffolded experiences to prepare teachers to enact high-quality instruction [10][23][24]. One approach to practice-based teacher education includes the design and facilitation of approximations of practice [25].

There are numerous studies that have examined the affordances of approximations of practice that include teachers reviewing video of their own teaching [21] and coached classroom discussions [26]. These studies can be organized into two categories, the first of which are studies that explore the teachers learning a set of instructional moves and responses that center student thinking and work to press on student thinking. For example, researchers have identified discussion moves that work to elicit student thinking and provide concrete exemplars for teachers to adapt and use during mathematics instruction [14]. These studies help educators to conceptualize and enact responsive teaching practices.

The second category of studies that examine approximations of practice involve teacher educators shifting their focus from a set of behaviors or actions to a focus on the teacher as an instructional decision-maker who can leverage core practices that keep learner thinking central to teaching and learning [8][10][26][27]. One finding from these studies involves the idea that because teaching is dynamic, practice spaces should not be scripted, allowing educators to have time and space to examine learner thinking and to respond and act spontaneously [8][25][28]. A second characteristic involves the idea that approximations of practice should be authentic in terms of its setting (i.e., using video of an actual classroom), its artifacts (i.e., the use of student work), or in the nature of the activity (i.e., writing specific questions to ask students) [8]. These characteristics of effective approximations of practice helped to conceptualize the approximation of practice used in this research, which was designed to engage participants in the professional noticing of children's mathematical thinking.

2.4. Professional Noticing of Children's Mathematical Thinking

Professional noticing of children's mathematical thinking hereafter referred to as professional noticing, involves three skills: (1) attending to children's strategies, (2) interpreting children's understanding, and (3) deciding how to respond based on children's understanding [7]. According to prior research, professional noticing skills do not happen in isolation; they are interrelated and often cyclical [7]. Research exploring the interrelated nature of professional noticing skills often considers attending and interpreting together and explores the relationship of these two skills with the skill of deciding how to respond [7][29][30]. For example, Monson et al. [30] discovered that after participation in a learning module designed to support prospective teachers in attending to student strategies and deciding how to respond they not only showed growth in deciding how to respond but also showed gains in attending and interpreting.

This research confirms and expands the understanding of how teachers engage in instructional reasoning in ways that have pedagogical value and empirical implications for teacher education. This research distinguished between two types of instructional reasoning. The first focused on teachers' purposes for their deciding actions. This type of

instructional reasoning is empirically important because it provides additional evidence of the often-hidden instructional reasoning that supports responsive teaching practices.

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