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Investigating the relationships among elementary teachers' perceptions of the use of students' thinking, their professional noticing skills, and their teaching practices

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ABSTRACT

This study is an investigation of relationships among elementary teachers' perceptions of the use of students' thinking in instructional decision-making, their professional noticing skills, and their use of students' thinking during instruction. Interviews were conducted with 33 participants using a two-part, semi-structured protocol and 25 teachers' instructional videos were collected. The data were analyzed using the Mathematical Quality of Instruction instrument and grounded theory techniques including open coding, identification of themes, and the development and description of categories. Preliminary findings suggest that there is a relationship between elementary teachers' perceptions of the use of students' thinking and their professional noticing skills, but misalignment was found between teachers' perceptions of the use of students' thinking and their practices as observed in videos of their own teaching. Implications are discussed for teacher knowledge and the design of effective professional development programs to encourage productive use of students' thinking in lesson planning and teaching.

Research has shown the educational value of understanding students' thinking and responding to it in the moment of teaching (e.g., Jacobs, Lamb, & Philipp, 2010; Sherin, Jacobs, & Philipp, 2011, Sherin & van Es, 2009). To understand the underlying complexities of teachers' in-the-moment decision making, Jacobs et al. (2010) explored how prospective and practicing teachers attend to mathematical activity during instruction. They identified a set of interrelated skills referred to as *professional noticing of children's mathematical thinking*. Professional noticing includes (a) attending to students' strategies, (b) interpreting students' understandings, and (c) determining how to respond based on these understandings.

However, much remains to be learned about the antecedents of *noticing* skills, the cognitive and psychological factors involved, and how to support teachers in developing them. Cognitive, psychological, and physical factors (e.g., school environment, classroom resources etc.) have been found to influence the breadth of teachers' behaviors (e.g., Cross Francis, 2015; Schoenfeld, 2011; Star & Strickland, 2007). This suggests there is value in investigating how teachers perceive the uses of students' thinking and how their perceptions influence their practices.

Beginning with the premise that teachers need to first value a resource before committing to using it, the purpose of this study was to examine the relationships among elementary teachers' perceptions of the use of students' thinking, their professional noticing skills, and their teaching practices. In the following sections, we review the relevant literature on students' mathematical thinking, teachers' professional noticing, and psychological influences on teachers' behavior. Then we describe the methods used, and discuss

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the findings and their implications.

1. Review of the literature

1.1. Students' mathematical thinking

Mathematics education researchers have found substantial evidence that attending to students' thinking can yield positive learning outcomes (e.g., Franke, Kazemi, & Battey, 2007; Silver & Stein, 1996). In the early 1990s, U.S. federal agencies (e.g., the National Science Foundation) funded several large-scale projects (e.g., Cognitively Guided Instruction (CGI) project) focused on students' thinking (Franke et al., 2009). Subsequently, knowledge gained from such projects has been developed into teacher-supported curricular materials. However, having access to these materials is not sufficient to ensure that teachers will utilize them effectively to support students' thinking (Cengiz, Kline, & Grant, 2011).

Accordingly, researchers developed supportive instructional frameworks, such as Advancing Children's Thinking (ACT) (Fraivillig, Murphy, & Fuson, 1999) and Extending Students' Thinking (EST) (Cengiz et al., 2011) as well as guidelines for supporting thinking in the whole class context (Leatham, Peterson, Stockero, & Van Zoest, 2015; Smith & Stein, 2011). However, for teachers to invest in developing expertise in noticing and in extending students' thinking, they first needed to accept it as a valuable learning resource. Accordingly, a line of research developed to examine how teachers viewed student thinking, resulting in a focus on teacher noticing.

1.2. Professional noticing of students' mathematical thinking

Research on teacher noticing, a form of *professional vision* (Lee & Choy, 2017; Goodwin, 1994), centers on efforts to unpack the key components of this practice and the knowledge and skills teachers need to apply it. Most notable here is Jacobs and colleagues' (2010) construct of *professional noticing of children's mathematical thinking*, which comprises three skills:

- *attending to students' strategies* (noticing how students tackle problems as evidence of their mathematical reasoning),
- *interpreting students' mathematical reasoning* (determining the extent to which instructional reasoning is consistent with both students' reasoning and the research on students' mathematical development), and
- *deciding how to respond based on students' reasoning* (making conscious attempts to use what has been learned about students' understandings and being aware of how their instructional responses are linked to their attending and interpreting skills). This latter aspect, responding to what one notices, is the most complex and challenging.

Several researchers have examined the extent to which teachers attend to important details of students' productions and their substantive reasoning rather than to superficial features of the classroom such as the general environment, students' behavior issues, or teacher pedagogy (e.g., Frederiksen, Sipusic, Sherin, & Wolfe, 1998; Leatham et al., 2015; Sherin & Han, 2004; van Es, 2011; van Es & Sherin, 2002). To *notice,* teachers must focus on attending to particular students' mathematical thinking and its relationship to their teaching strategies. In particular, teachers need to attend to students' utterances that shed light on their thinking, including correct and incorrect answers, procedural mistakes, justifications, and explanations, etc. Students' errors can be particularly illuminating, but Boaler (2016) has found that teachers in North America are less likely than teachers in China to attend and respond to them. Also exploring students' partial understandings is an important teaching strategy for strengthening their mathematical thinking (McNamara & Shaughnessy, 2011; Saxe et al., 2010).

Studies on teachers' noticing have often used videos as a tool to analyse children's mathematical thinking (e.g., Sherin & van Es, 2009). Several studies (e.g., Jacobs, Lamb, Philipp, & Schappelle, 2011; Kazemi et al., 2011; van Es, 2011) have shown that videos can be used to shift teachers' foci from children's mathematically irrelevant actions (low-level noticing) to their mathematical ideas (high-level noticing). For example, Star & Strickland (2007) found that developing prospective teachers' noticing abilities improved their attention to the salient features of secondary students' mathematical thinking. In their study of 131 prospective teachers and practicing teachers, Jacobs et al. (2010) found that prospective teachers struggled with all three components of noticing. However, through professional development (PD), experienced teachers showed growth in all three skills, particularly attending to students' strategies and understandings (also supported by Ainley & Luntley, 2007; Dreher & Kuntze, 2015).

Schoenfeld (2010) also emphasized the important role teachers' knowledge and orientations play in noticing and the decisions they make. Dreher and Kuntze (2015) observed "when a teacher notices successfully, we can draw conclusions regarding his or her professional knowledge and views" (p. 94). Thus, experienced teachers will more likely be able to draw on their accumulated knowledge of content, students and pedagogy to identify and act on valuable pedagogical opportunities. However, prior research found that teaching experience did not guarantee noticing expertise (Lee & Choy, 2017; Jacobs et al., 2010).

These studies support the notion that teachers need deep understanding of their discipline as well as skills in crafting instructional moves to support student learning (Gibson & Ross, 2015). Schoenfeld (2011) further argues that knowledge, while important, is not the only construct that influences teachers' noticing and related decision-making. He encouraged researchers to examine other factors, including teachers' goals and orientations, in order to make sense of their motivations and actions.