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Investigating Secondary Preservice Teachers' Noticing of Student Thinking

Perspectives and Relevance

In order to effectively implement student-centered instruction, teachers are required to recognize and interpret student thinking and also consider students' current understandings and methods as a basis for instruction (Franke, Kazemi, & Battey, 2007; NRC, 2001). In NCTM's recent publication, Principles to Actions (National Council of Teachers of Mathematics, 2014), eliciting and incorporating evidence of student thinking as a basis for instruction is promoted as one of eight research based practices. Research at the elementary level has shown positive association between student achievement and teachers' ability to elicit and build upon student thinking during instruction (Bobis et al., 2005; Jacobs, Franke, Carpenter, Levi, & Battey, 2007). While the empirical link is less established at the secondary level, there is a strong theoretical foundation to support the claim that a similar focus on student thinking by secondary teachers will result in more student-centered instruction and increase students' mathematical understanding (Brown & Cocking, 2000; Walshaw & Anthony, 2008). There is a need for research that examines how we can support secondary teachers' abilities to notice student thinking and how this noticing can be characterized.

Our use of noticing draws upon a conceptualization of *professional noticing of student thinking* (Jacobs, Lamb, & Philipp, 2010) comprised of three interrelated skills of "attending to children's strategies, interpreting children's understandings, and deciding how to respond on the basis of children's understandings" (p. 172). Teachers must first notice (attend) the particular mathematical ideas evident in student's written work or verbal responses in order to make sense of (interpret) that thinking so that it can inform the teachers' next steps (respond).

Based on promising work conducted with practicing and preservice teachers at the elementary level to scaffold teacher noticing (Jacobs et al., 2010; McDuffie et al., 2013; Schack et al., 2013), we propose that secondary preservice teachers (PSTs) will similarly be supported in their development of professional noticing through engaging in an interview assignment. The aim of this study is to determine whether a curricular module, centered upon a task-based interview assignment, conducted as part of a secondary mathematics methods course improves PSTs' attention to and analysis of student thinking.

Methods and Data Sources

We report upon the following two research questions: *(1) What impact does a curricular module have on secondary mathematics PSTs' noticing of student thinking?*, and *(2) What is the nature of secondary PSTs' noticing of student thinking in a task-based interview?* We collected data from a curricular module embedded in secondary mathematics methods courses to answer these questions. The purpose of the module was to develop PSTs' abilities to analyze student thinking in relation to core mathematical ideas and to further build their understanding of how to elicit students' thinking. We designed the module to center upon an assignment adapted from Huntley, Marcus, Kahan, and Miller (2007), on the topic of solving linear equations, where the PSTs conduct a task-based structured interview[1].

The 32 participants for this study were PSTs enrolled in secondary mathematics methods courses at three universities spread throughout the U.S. Participating in the study included taking a pre-assessment, conducting an interview with a student enrolled in 8^{th}-12^{th} grade, completing a reflection paper, and taking a post-assessment. The pre/post assessment involved

[1] For more information on the design of the module and initial findings see Lesseig, Casey, Monson, Krupa, and Huey (under review). To read more about the research design and findings from two analyses see Krupa, Huey, Lesseig, Casey, and Monson (Accepted).

viewing a video of a task-based interview with a student and responding to three prompts, which assessed the PSTs' ability to **attend to** the mathematics the student was engaging in, **interpret** student thinking, and decide how to **respond** instructionally based on this thinking. The final reflection paper was designed to give PSTs an opportunity to present the results of the interview and reflect the experience and was written after the PST conducted and transcribed the interview.

Results

Research Question 1. The PSTs provided evidence of both *attending* to and *interpreting* students' mathematical thinking on the post-assessment, but limited evidence of *responding* appropriately to students. From pre- to post-assessment, PSTs exhibited gains in *attending* to students' mathematical ideas and *interpreting* (**Error! Reference source not found.**) with no change in *responding* to students.

Table 1. Comparison of Responses on the Pre- and Post-Assessments

Assessment Score	Attending			Interpreting		
Pre- / Post-	No Evidence	Limited	Emerging Ability	No Evidence	Limited	Emerging Ability
No Evidence	9 (28%)	0 (0%)	0 (0%)	1 (3%)	1 (3%)	1 (3%)
Limited	6 (19%)	5 (16%)	3 (9%)	3 (9%)	13 (41%)	2 (6%)
Emerging	3 (9%)	3 (9%)	3 (9%)	1 (3%)	4 (12%)	6 (19%)

Data indicates that the component skill of *interpreting* was easier, or perhaps more natural, for PSTs than *attending*. The module supported more productive noticing in the sense that the scores for *interpreting* and *attending* were more closely aligned on the post-assessment and suggests that the PSTs were basing their interpretations on the evidence at hand. However, 31% of PSTs still scored higher on *interpreting* than *attending* on the post assessment. Overall, after the interview assignment, PSTs' responses showed more focus on student thinking and to ideas specifically raised in the methods course, including attention to graphical methods for

solving systems of equations, making connections across representations, and checking solutions.

Research Question 2. Three major themes emerged in coding the reflection papers: (1) limitations in students' mathematical knowledge and problem-solving approaches; (2) interpretations of student thinking and behavior; and (3) broad benefits of interviewing students. PSTs noticed that students relied on procedural methods, were unable to make connections across representations, and had difficulty making sense of the solutions they produced. Our analysis revealed that PSTs often felt compelled to provide a rationale for students' correct or incorrect answers and particular approaches. PSTs most often attributed this lack of conceptual understanding to students' prior experiences in mathematics classes and often referenced the emphasis placed on symbolic methods evident in their own education. Finally, PSTs noted the power of the interview assignment to reveal student strategies and described the importance of eliciting student thinking through questioning.

Conclusions

Though asking PSTs to interview students is not necessarily a novel assignment, its use with secondary mathematics PSTs is not well documented and little is known about what they learn through these experiences. Our findings indicate that this interview assignment advanced PSTs' noticing of student thinking, which is especially critical for secondary education students whose preparation is typically focused on content knowledge. Moreover, our characterization of what PSTs notice highlights broad benefits of conducting one-on-one student interviews. These benefits include a heightened awareness of students' general problem-solving strategies and the need for questioning strategies to reveal and/or guide student thinking.

Mason (2002) stated, “every act of teaching depends on noticing” (p. 7). We are working toward developing the noticing discipline by supporting PSTs’ attention to this deliberate practice. Throughout the curricular module, we highlight that attending to students’ mathematical thinking is a critical aspect of designing instruction. In addition, we have developed a common set of assignments and activities that advance secondary PSTs’ noticing of student thinking that can be shared with other mathematics teacher educators. Collectively, we are documenting what we have learned about PSTs’ initial noticing so that we can design activities to further support more productive noticing.

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