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Studying teacher noticing: Examining the relationship among pre-service science teachers' ability to attend, analyze and respond to student thinking☆

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HIGHLIGHTS

- We investigated two cohorts of teacher candidates in a preparation program.
- One cohort was enrolled in a course to develop reflective skills using video.
- Course participants attended to and analyzed student ideas differently.
- Sophisticated analyses and responses required high sophistication in attending.
- Significant relationships existed between attending and analyzing.

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ABSTRACT

This study investigates pre-service teachers' capacities to attend to, analyze, and respond to student thinking. Using a performance assessment of teacher competence, we compare two cohorts of science teacher candidates, one that participated in a video-based course designed to develop these skills and one that did not. Course participants demonstrate more sophisticated levels of attention to and analysis of student ideas. Analysis of the relationship among skills reveals that sophisticated analyses and responses to student ideas require high sophistication in attending to student ideas. However, high sophistication in attending to student ideas does not guarantee more sophisticated analyses or responses.

1. Introduction

Few factors have a greater impact on learning than the quality of a student's teacher (Darling-Hammond, 2010; Strauss & Sawyer, 1986; Whitehurst, 2002). While there is disagreement about what specific skills or dispositions make one teacher more effective than another (Goldhaber & Anthony, 2004), there is consensus around the importance of teachers being able to critically analyze their practice (Little & Horn, 2007; Windschitl, Thompson, & Braaten, 2011). Teachers who have opportunities to rigorously reflect on their work and connect it to research and theory during their professional preparation are better able to identify and respond to dilemmas of practice, more likely to take an analytic stance toward their work, and demonstrate a willingness to take risks and explore alternative pedagogical approaches (Darling-Hammond & Bransford, 2005; Davis, Petish, & Smithey, 2006; Zeichner & Liston, 1996). Moreover, research on teacher expertise shows that expert teachers can distinguish between important and unimportant information in a complex situation, can reason about what they observe and can use this analysis to make more informed teaching decisions (Berliner, 2001).

Despite its value, building reflective and analytic skills can be challenging, particularly in the context of pre-service teacher education. The fieldwork sites may not promote systematic and rigorous analysis; the preconceptions pre-service teachers bring

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into the profession can interfere with what they choose to reflect on and how they reason about the effectiveness of their teaching; and pre-service teachers may lack the observation skills and pedagogical content knowledge required for sophisticated analyses of teaching and learning (Borko & Livingston, 1989; Hammerness, Darling-Hammond, & Bransford, 2005; Hiebert, Morris, Berk, & Jansen, 2007; Schoenfeld, 2011; Star & Strickland, 2008).

A further complication is that simply adding requirements to teacher education programs to analyze practice, be it through coursework assignments or high-stakes portfolio assessments, without providing guidance in what should be analyzed, for what purpose, and how, results in superficial learning and may even be mis-educative (Dewey, 1933; Loughran, 2002; Zeichner & Liston, 1996). This is because, without structured support and appropriate framing, pre-service teachers' analyses tend to focus on the actions and behaviors of the teacher rather than student thinking, learning and sense-making (Hammer, 2000; Levin, Hammer, & Coffey, 2009), and tend to be judgmental and lack evidential support and coherence (Davis, 2006; Sandoval, Deneroff, & Franke, 2002).

The purpose of this study is to investigate how a video-based course, *Learning to Learn from Teaching* (Santagata & van Es, 2010), supported secondary science pre-service teachers in learning to analyze and reflect on teaching and learning in systematic ways. A central component of the course was learning to use evidence of student thinking as it unfolds in the lesson to draw inferences about the effectiveness of instruction and using this analysis to make subsequent pedagogical decisions. This type of analysis requires that pre-service teachers: a) attend to student thinking and learning and the interactions that unfold among students and between teachers and students, b) interpret student understanding from these interactions, and c) decide next steps based on this analysis. Recent research refers to this collection of skills as teacher noticing (Jacobs, Lamb, & Philipp, 2010). Of particular interest in this study is the relationship among these skills. To date, several researchers have investigated these skills in isolation, with some researchers focusing on pre-service teachers' abilities to articulate clear learning goals (Jansen, Bartell, & Berk, 2009; Morris, Hiebert, & Spitzer, 2009), others on their ability to attend to student thinking and learning in a lesson (Levin et al., 2009; Nicol & Crespo, 2004; Ruiz-Primo & Furtak, 2007; Star & Strickland, 2008; van Es & Sherin, 2002; van Zee & Minstrell, 1997), and others on the use of evidence to support claims of teaching effectiveness (Morris, 2006; Santagata & Yeh, 2013; Stockero, 2008). Less attention has been paid to how development of one skill influences development of the others and how they coordinate to construct a coherent analysis of teaching practice. An empirical investigation into this relationship will advance research on the constructs of noticing and analysis of teaching and has implications for the design of teacher education.

While research suggests that pre-service teachers can develop analytic skills in the context of a course where they analyze their own and other's teaching (Pang, 2011; Santagata & Angelici, 2010), few studies have examined whether they draw on these skills when they analyze their own teaching after the conclusion of the course. Thus, the central research questions for this study include: a) Do pre-service teachers who participated in a course designed to scaffold systematic analysis of teaching through video analysis draw on the skills to analyze their own teaching compared to a cohort of teachers who did not participate in the course? and b) How are the skills of systematic analysis of teaching related to each other? To investigate these questions, we compare written analyses of teaching of a cohort of secondary science teacher candidates that participated in the *Learning to Learn from Teaching* (LLfT) course to one that did not in the context of a performance assessment for teacher credentialing. To be clear, we do not focus on noticing and analysis during instruction. Though research points to the value of preparing beginning teachers to learn to notice and respond during instruction (Kazemi, Lampert, & Franke, 2009; Windschitl, Thompson, Braaten, & Stroupe, 2012), we focus on their written analyses of teaching because research also suggests that teachers who systematically analyze teaching become more adept at responding to student ideas (Windschitl et al., 2011). In addition, we conjectured that the written responses would provide us with access to pre-service teachers' ways of attending, analyzing and responding, not all of which may be possible to observe if we were to analyze videos of instruction.

The questions we investigate are particularly relevant in science education internationally. In the US, proposals for the improvement of science teaching and learning emphasize teaching students how to collect, interpret, and evaluate evidence to formulate scientific explanations (American Association for the Advancement of Science [AAAS], 2009; National Research Council [NRC], 2007, 2012; Sandoval et al., 2002; Windschitl, Thompson, & Braaten, 2008). This is also the case in other countries where science curricula emphasize the importance of developing scientifically literate citizens and is reflected in the highest proficiency levels on the Program for International Student Assessment [PISA] (OECD, 2013; Waddington, Nentwig, & Schanze, 2007). Because the scientific body of knowledge is in constant flux with increasing amounts of information being added or modified (Gleick, 2011), students must be able to ask critical questions and possess appropriate skepticism about proposed explanations and interpretations of scientific phenomena. Moreover, they need to successfully navigate the flood of information to participate knowledgeably in public discussions about science and technology and be sensible consumers of information about science and related issues (NRC, 2012). Thus, learning science is not only about knowing science content, but also involves attending to and reasoning about scientific ideas, generating and testing models of scientific phenomena, and being effective problem solvers (AAAS, 2009; Levin et al., 2009; Ministry of Education-Singapore, 2013; NRC 2012). To achieve this vision of science education requires that pre-service teachers develop strategies for systematically analyzing their ability to build students' scientific reasoning skills and for assessing students' progress in achieving these goals.

2. Theoretical framework

2.1. The importance of reflection and analysis for learning to teach

This study is framed by research on reflection, teacher noticing and lesson analysis. Dewey (1933) and Schön (1983) each made contributions to the field by defining the phases and mind-set needed for critical reflection. Each believed reflective practitioners should be engaged in ongoing, systematic, rigorous, and disciplined meaning-making with the aim of improving practice. They identified effective reflection as an analytic approach to problem-solving distinct from informal ways of thinking about teaching and instruction in which teachers direct their attention to particular details of practice, make sense or give reason to these details, and use their analysis of these details to develop hypotheses about how to solve dilemmas of classroom practice. In this way, teachers become skilled professionals rather than mindless technicians who consume and implement instruction designed by others.

An important characteristic of these reflective models is the use of evidence from teaching to inform practical theories to test in practice. In Dewey's (1933) perspective, all rigorous reflection is