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Research paper

Affordances of video-based professional development for supporting physics teachers' judgments about evidence of student thinking

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HIGHLIGHTS

- We studied professional development using videos with evidence of student thinking.
- We examined the quality of teachers' discussions of video and resulting judgments.
- Quality of teachers' judgments was related to the quality of their discussions.
- Elaborated focus questions appear to support higher quality discussions.
- Working with colleagues appears to foster higher quality discussions and judgments.

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An earlier report of these results was presented at the 2013 annual meeting of the American Educational Research Association (*Beginning Physics Teachers' Noticing in a Video-Based Professional Development Workshop Designed to Support PCK*, Kim & Alonzo).

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ABSTRACT

This study explores the affordances of a video-based professional development workshop for supporting physics teachers' content-specific judgments about evidence of student thinking. We rated both the quality of teachers' discussions and the judgments that resulted as they discussed video clips highlighting student thinking. We found that teachers' judgments were related to the quality of their discussions. Quantitative and qualitative analyses suggest that elaborated focus questions and interactions with colleagues may support teachers with relatively little physics teaching experience in using their collective wisdom to engage in a situation-specific skill necessary for responsive teaching.

Responsive teaching requires teachers to make on-the fly judgments about evidence of student ideas[1]—e.g., which ideas are important to attend to, the meaning and significance of those ideas, what response(s) would be appropriate (Hammer, 1997). Decisions about how to respond to a particular student contribution (e.g., ask a follow-up question, plan to alter upcoming instructional plans) rest on a series of judgments that teachers must make in the moment. These judgments arise as teachers attend to student thinking (e.g., What does the student's contribution reveal about her ideas about the content?), reason about student thinking (e.g., Why might she have these ideas?), and respond to student thinking (e.g., What strategies do I have for responding?)—as well as consider logistics (e.g., time considerations) and the socio-emotional climate of the classroom.

These judgments can be challenging for all teachers (e.g., Heritage, Kim, Vendlinski, & Herman, 2009; Ruiz-Primo & Furtak,

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[1] We emphasize that teachers do not have direct access to students' ideas or thinking; rather, they must make inferences on the basis of available evidence. However, for readability, we often use the shorthand of "student ideas" or "student thinking," in place of "evidence of student ideas" or "evidence of student thinking" in this article.

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2007; Schneider & Gowan, 2013; Schneider & Plasman, 2011; Stahnke, Schueler, & Roesken-Winter 2016). However, since these judgments rely on significant teaching-specific content knowledge that develops with experience (van Driel, Verloop & de Vos, 1998), those with little experience teaching a given subject may face particular challenges. Thus, our work addresses the need to support these teachers in making content-specific judgments about student thinking. In the context of a video-based professional development workshop (PDW), we explore how physics teachers with relatively little experience teaching this subject discuss and make judgments about student thinking. Given recommendations for professional development (PD) that "tap[s] local expertise" and teachers' "collective wisdom" (Feiman-Nemser, 2001, p. 1042), as well as constraints on the outside expertise available to large numbers of teachers, we also investigate how interactions with colleagues and questions designed to guide discussions during the PDW may support these discussions. In the section below, we provide further detail about the literature that both informs our work and provides a rationale for this study, concluding with our research questions.

1. Introduction

Without extensive teaching experience and associated experienced-based knowledge, like newcomers to other fields (e.g., Goodwin, 1994), novice teachers[2] may direct their attention to student ideas but still not "see" what is necessary to make judgments about what their students are thinking and how they should respond. Even with support, novice teachers may view students' ideas as holistically either "right" or "wrong" (e.g., Gotwals & Birmingham, 2016; Levin, Hammer, & Coffey, 2009); these dichotomous judgments do not support instructional decisions responsive to students' learning needs (e.g., Minstrell, Anderson, & Li, 2011). However, another group of teachers in today's schools are likely to experience similar content-related challenges. In many countries, out-of-subject teaching—i.e., teachers teaching courses outside of their major certification—is a significant concern (e.g., Hobbs, 2015). This problem is especially acute in secondary science, particularly for those teaching physics content (e.g., Childs & McNicholl, 2007; Luft, Hill, Weeks, Raven, & Nixon, 2013).[3] Out-of-subject teachers may teach primarily in their major certification area, but occasionally teach a course or two in a different subject. Not only do they have less content knowledge in the out-of-subject area, they develop less experience teaching that subject as compared to their major subject and learn less from those experiences (e.g., Luft et al., 2013), such that they may continue to be under-qualified to teach the out-of-subject content even after years in the classroom. Indeed, there is evidence that those teaching out-of-subject, while able to cope with general pedagogical demands, feel (e.g., Childs & McNicholl, 2007) and behave (e.g., Sanders, Borko, & Lockard, 1993) like novices with respect to subject-specific demands, such as detecting student misconceptions and interpreting students' comments (e.g., Hashweh, 1987). Thus, both truly novice teachers and those with more experience but teaching out-of-subject may have difficulty making judgments about student thinking.

Teacher PD is often viewed along a continuum (e.g., Feiman-Nemser, 2001) or in stages (e.g., Kagan, 1992). Although these stages may not be "universally applicable" and require "flexibility and adaptability" when used to inform teacher education (e.g., Loughran, 2006, p. 108), it is widely assumed that beginning teachers (i.e., those prior to and in their first two years of in-service teaching) will be primarily concerned with their own identity and actions (Levin et al., 2009). Thus, "deepening and extending subject matter knowledge for teaching" (Feiman-Nemser, 2001, p. 1039) is viewed as a central task of PD for early career teachers (post-induction, approximately years 3–5). While early career teachers should develop in other areas as well, this is where their needs overlap with those of out-of-subject teachers, who may have developed pedagogical skills and knowledge for teaching their primary subject, but need to deepen their expertise in a second subject. Recommendations for PD beyond the induction stage (applicable to early career and more experienced out-of-subject teachers) emphasize the importance of teachers' "professional discourse involv[ing] rich descriptions of practice, attention to evidence, examination of alternative interpretations, and possibilities," and "teachers helping teachers" (Feiman-Nemser, 2001, pp. 1043–1044).

1.1. Video-based professional development

Video has become a prominent means of supporting teacher development in countries around the world (e.g., Blomberg, Sherin, Renkl, Glogger, & Seidel, 2013; Gaudin & Chaliès, 2015). Video has been used to support both beginning (e.g., Gotwals & Birmingham, 2016; Levin et al., 2009) and in-service (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Sherin & Han, 2004) teachers' attention to and reasoning about student thinking. Videos can capture transient moments of classroom instruction, making them available for considered reflection and collaboration. While allowing teachers to engage with the complexity and messiness of real teaching situations (e.g., Sherin, Linsenmeier, & van Es, 2009), video also affords time for practicing the type of judgments that are needed in on-the-fly situations, without the pressure to respond immediately. This is particularly important since decisions to be made on the basis of these judgments often take place within the ill-defined complexity of classroom situations (e.g., Eliam & Poyas, 2006; Kennedy, 2006; Lampert, 2001), requiring teachers to consider not only their judgments, but a myriad of other factors.

Work on video-based PD has contributed a deeper understanding of the conditions that support meaningful learning in these settings. Particularly because much of the research on video-based PD has been conducted in the context of long-term "video clubs," in which teachers share their own videos, researchers have paid particular attention to the social and emotional environment of teachers' learning, emphasizing the importance of a supportive professional learning community (e.g., van Es, 2012; Gröschner, Seidel, Pehmer, & Kiemer, 2014). In these contexts, the facilitator plays a crucial role, often "setting up and moderating the discussion, describing what the teachers should look for in the video clip and helping them to make sense of the classroom events" (Borko et al., 2008, p. 428)—through both ongoing "facilitation moves" (e.g., van Es, Tunney, Goldsmith, & Seago, 2014, p. 345) and formal discussion questions (e.g., Borko et al., 2008). Thus, prior research has attended to the cognitive support provided by facilitators and to the socio-emotional support provided by other teachers in long-term video-club-style PD. There has been less attention to the cognitive support that teachers may provide to each other and to

[2] We use "novice" to refer to pre- and in-service teachers with up to five years of experience. We further distinguish "beginning" teachers (those with less than three years of experience) from "early career" teachers (those in their 3rd-5th years of teaching).

[3] In the United States, this is attributable both to the shortage of secondary physics teachers common in many countries and to the structure of the curriculum. High school physics teachers may teach "physical science" and/or "physics" courses. At the time this study was conducted, physical science was an introductory—often required—course, covering topics in both physics and chemistry, with enrolled students typically ages 14–16. Physics was a more advanced course often taken after physical science and typically enrolling college-bound students ages 16–18. Because physical science covered both chemistry and physics topics, it could be taught by teachers with primary expertise in either chemistry or physics.

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