Teaching and Teacher Education 66 (2017) 74–87

Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate

Exploring the development of core teaching practices in the context of inquiry-based science instruction: An interpretive case study

Jill McNew-Birren [a], Leigh A. van den Kieboom [b,*]

[a] Marquette University, College of Education, P.O. Box 881, Walter Schroeder Health Complex #113a, Milwaukee, WI 53201-1881, United States
[b] Marquette University, College of Education, P.O. Box 881, Walter Schroeder Health Complex #113c, Milwaukee, WI 53201-1881, United States

HIGHLIGHTS

- Teacher practice develops through effective teaching and professional experience.
- Effective inquiry-based science instruction depends on core teaching practices.
- Teacher questioning can indicate of understanding of inquiry-based instruction.
- Teacher questioning can indicate development of professional practice.

ARTICLE INFO

Article history:
Received 7 October 2016
Accepted 7 April 2017

Keywords:
Core teaching practices
Inquiry-based science instruction
Teacher development
Teacher questioning

ABSTRACT

This paper describes our reflection on a clinical-based teacher preparation program. We examined a context in which novice pre-service teachers and a mentor teacher implemented inquiry-based science instruction to help students make sense of genetic engineering. We utilized developmental models of professional practice that outline the complexity inherent in professional knowledge as a conceptual framework to analyze teacher practice. Drawing on our analysis, we developed a typography of understandings of inquiry-based science instruction that teachers in our cohort held and generated a two dimensional model characterizing pathways through which teachers develop core teaching practices supporting inquiry-based science instruction.

1. Introduction

Emphasis on inquiry-based teaching practices in science classrooms around the world (Achieve Inc, 2013; Krainer, Jungwirth, & Stadler, 1999; Wake & Burkhardt, 2013) has shifted the focus of teaching away from delivering content and toward supporting students in making sense of concepts by "figuring out phenomena" (Krajcik, 2015). To help teachers make this shift, teacher education researchers have identified core teaching practices that emphasize student sense making via inquiry-based instruction (Grossman, Hammerness, & McDonald, 2009; Kazemi, Franke, & Lampert, 2009; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010, pp. 129–141; Lampert et al., 2013). In the U.S., researchers have begun to re-conceptualize teacher preparation by: (1) identifying core teaching practices that effective and experienced teachers utilize when implementing inquiry-based instruction, and (2) providing novice pre-service teachers' opportunities to rehearse core teaching practices through clinical-based coursework. Ball, Sleep, Boerst, and Bass (2009) specified that such practices: (1) occur frequently during instruction, (2) maintain the complexity involved in teaching and learning, and (3) have the potential to improve student learning and achievement. Across disciplines, researchers identifying core teaching practices have produced complex models that specify advanced behaviors through which teachers support student sense making during inquiry-based instruction. Our experiences in teacher preparation, however, suggest that novice pre-service teachers struggle to both understand the complexity and nuance of core teaching practices, and use core teaching practices effectively to implement inquiry-based instruction and support student sense making.

This interpretive case study describes our reflection on a clinical-based teacher preparation program in which novice pre-service teachers implemented inquiry-based science instruction to help students make sense of genetic engineering. The setting of

* Corresponding author.
E-mail addresses: jill.birren@marquette.edu (J. McNew-Birren), leigh.vandenkieboom@mu.edu (L.A. van den Kieboom).

http://dx.doi.org/10.1016/j.tate.2017.04.001
0742-051X/

our reflection was a U.S. teacher preparation program designed after a co-op model from engineering, which engaged a small cohort of novice pre-service teachers in science methods coursework embedded in the classroom of a more experienced high school science teacher (van den Kieboom, Birren, Eckman, & Silver-Thorn, 2013). The classroom was selected as a site for the co-op based on the high school teacher's reputation as skilled in inquiry-based science instruction.

Our teacher education model reflected recent U.S. reform recommendations which place clinical practice at the center of teacher preparation (Grossman et al., 2009; National Council for Accreditation of Teacher Education, 2010). The individual attention and clinical emphasis of this context appeared favorable for supporting novice pre-service teachers to develop mastery of core teaching practices that support successful implementation of inquiry-based science instruction. However, extensive reflection on video-recorded teaching during the co-op provided an opportunity to examine the challenges novice pre-services teachers encountered while enacting core teaching practices supporting inquiry-based science instruction. Analysis of our clinical data in light of the literature on developmental trajectories of professional practice (Dall'Alba & Sandberg, 2006; Dreyfus, 2004) led us to consider assumptions about the developmental readiness of novice pre-service teachers to enact core teaching practices, specifically teacher questioning, which supports inquiry-based instruction with fidelity. Teacher questioning, in particular, emerged as an important indicator of varied levels of development of core teaching practices. Although teacher questioning itself has not been named as a core teaching practice, the centrality of teacher questioning is evident in classroom discourse across various models. Thus, a theoretical contribution of this paper is to bring current disciplinary emphasis on core teaching practices into conversation with extant literature emphasizing the importance of teacher questioning in inquiry-based science instruction, linking both to a framework for understanding professional development trajectories.

2. Conceptual framework

2.1. Inquiry-based science instruction

According to Minner, Levy, and Century (2010), "the term *inquiry* has figured prominently in science education, yet it refers to at least three distinct categories of activities – what scientists do, how students learn, and a pedagogical approach that teachers employ" (p. 3). Thus, inquiry-based pedagogy is a student centered approach to teaching that encourages the use of scientific processes to actively engage students in learning by building their own knowledge through hands-on, investigative activities (Achieve Inc, 2013; Steffe & Gale, 1995; Yager, 1991). Inquiry-based pedagogy encourages students and teachers to utilize practices similar to those of scientists who: (1) pose and investigate questions, (2) plan and design experiments, (3) prioritize evidence, (4) develop explanations connected to scientific knowledge, and (5) use data as evidence to share results (National Research Council [NRC], 1996). In facilitating student engagement in each of these processes, teachers often utilize questioning to guide students through scientific inquiry.

Despite the emphasis on inquiry-based science instruction in K-12 Science, Technology, Engineering, and Mathematics (STEM) reform initiatives around the world, teacher use of and success with this approach has largely been limited and inconsistent (Capps & Crawford, 2013; Marshall, Horton, & Smart, 2009). Researchers argue that many science teachers hold simplistic conceptions of: (1) scientific knowledge and (2) how inquiry-based instruction can be used to support students in investigating and constructing scientific knowledge (Capps & Crawford, 2013; Windschitl, Thompson, & Braaten, 2008). One way to support teachers in implementing inquiry-based science instruction is to specify the core teaching practices supporting inquiry-based instruction and to adequately prepare teachers to enact these practices during teacher preparation (Grossman et al., 2009).

2.2. Core teaching practices

Among the various models that have identified core teaching practices supporting inquiry-based instruction, the practice of teacher questioning is essential. For example, in mathematics education, Ball et al. (2009) identified leading whole class discussions and eliciting student thinking as core teaching practices that require effective questioning on the part of teachers to support students in making sense of concepts. Likewise, the model for core teaching practices supporting inquiry-based science instruction described by Windschitl, Thompson, Braaten, and Stroupe (2012) includes: (1) identifying a conceptual goal, (2) eliciting student ideas to adapt instruction, (3) eliciting student ideas to help students make sense of material activity, and (4) pressing students for evidence-based explanations. According to Hiebert, Morris, Berk, and Jansen (2007) novice pre-service teachers have particular difficulty identifying a robust and conceptual goal for their lessons. Windschtl et al. also emphasized the foundational position of the practice of identifying a robust conceptual goal, which must be in place in order for the three remaining discussion-oriented practices to be implemented effectively. Accordingly, in Fig. 1, we have illustrated the four core teaching practices for supporting inquiry-based science instruction with the practice of identifying a conceptual goal situated prominently as central to the model. Aside from the vital initial step of identifying a robust conceptual goal, each of the other core teaching practices in Windschitl et al.'s. framework requires skilled teacher questioning to support students in making sense of concepts.

2.3. Teacher questioning

Questioning supports science teachers in eliciting and building on student ideas as well as pressing students to use scientific evidence to explain their thinking during inquiry-based science instruction (Windschitl et al., 2012). Mathematics and science teacher

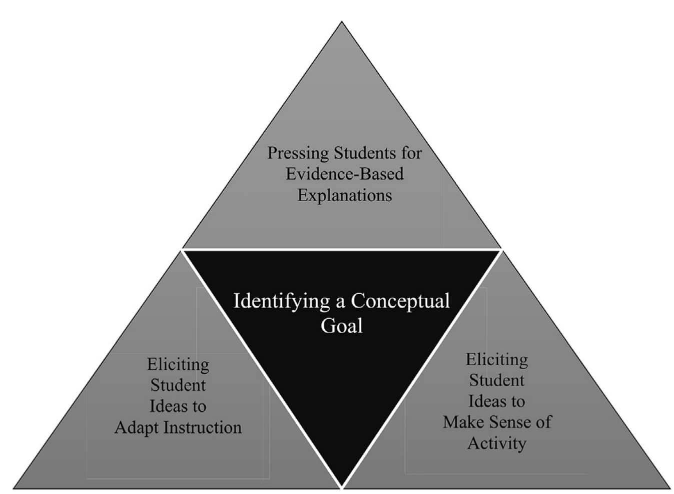

Fig. 1. Model of core practices supporting inquiry-based science instruction adapted from Windschitl et al. (2012).