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Exposing Elementary Teachers' Vulnerability: The Discomfort of Not Knowing

My Vexation

Over the past year, several colleagues and I worked closely with eleven fifth grade teachers in one of five partnership districts. Using cooperative inquiry (one of several approaches to participatory research [see Reason, 1994]) as a form of professional development for both the university (science and literacy teacher education faculty) and public school educators involved in the project, we collaboratively developed new and modified existing curricula based on the state science, mathematics, and literacy core curriculum guides. In short, our goal was to integrate the three academic subjects in meaningful ways using an inquiry approach to instruction.

During both the development and implementation phases of our work together, each participant came to better understand different aspects of the current context of teaching science in elementary classrooms. Although the experience introduced a number of perplexing issues, challenges, and related questions, the vexation that I have elected to share relates most particularly to the classroom teachers:

On multiple occasions it became evident that for these experienced classroom teachers our work together exposed feelings of insecurity with respect to teaching science. Not surprisingly, the teachers were largely unfamiliar with inquiry as a way of teaching science and struggled to understand how it might work with their particular students in their individual classrooms. Beyond the new pedagogy, however, and even more disquieting to the teachers was that despite six years of teaching the same science content, they clearly lacked a sound understanding of the science concepts they have been asked to teach. Not knowing made them uncomfortable and, rather than helping them feel more at ease with the content as misconceptions were addressed and concepts explained, the revelation of their limited conceptual understanding often, at least initially, left them feeling exposed and vulnerable.

As the teachers began to implement the interdisciplinary units, their limited conceptual understanding and feelings of vulnerability seemed to contribute to a number of interesting teacher behaviors in the classroom. First, without exception, it was clear that teaching science for these teachers was fundamentally a process of teaching vocabulary. Learning science, then, required verbatim memorization of definitions (even paraphrased definitions were not acceptable) and each science lesson began with a recitation of previously introduced science terms and their prescribed meanings. Additionally, all inquiry-based lessons were changed to a more direct instruction format, transforming the previously planned open-ended, student-centered activity into a more teacher-directed activity (or demonstration) and used primarily to verify or illustrate science principles or concepts while following clearly defined procedures. Moreover, there was a sense that these learning activities (typically hands-on experiences where students physically manipulated materials, although some were designed as text-based inquiries) were enacted for the sake of activity rather than to teach and clarify concepts. Only rarely did any of the teachers close the lesson or follow up any given activity with a discussion of how the activity related to a science concept. This left students excited about what they had experienced but unsure about its relationship to the vocabulary they had memorized or how the fun related to science concepts. Additionally, the teachers continued to display an inability to attend to student questions related to the content that were not expressly addressed in the curriculum. The teachers were reluctant to admit not knowing and even less inclined to suggest to students that they "find out together." As a result, on many occasions incorrect answers were offered and misconceptions introduced or reinforced. Too, there was a strong tendency to defer to university-based educators (even to the literacy educators and undergraduate research assistants) when questions were posed for which the teachers had no answer.

I realize, of course, that none of these observations are particularly groundbreaking. Elementary teachers' limited science content knowledge and its impact on instruction and student learning has been a concern and a topic of discussion for decades. More recently, science teacher educators have also widely studied the impact of teachers' knowledge of science on their inclination and ability to enact inquiry in their classrooms. Teacher-centered strategies often used in teaching science restrict group discussion to a defined body of knowledge (the teacher's) and allow teachers to control and limit learning to fit their own understanding of content. As well, we know that elementary teachers introduce, promote, and reinforce science misconceptions.

The focus of the vexation I share is not so much that many elementary teachers do not understand the science they are asked to teach (although their not knowing and its impact on children's understanding of science

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troubles me sorely). Rather, I am concerned that despite our knowledge of the impact of teachers' not knowing, we have been unable to satisfactorily address this problem. It is easy to place blame on the classroom teachers, suggesting that they are personally at fault for not learning the content they are asked to teach, that they are remiss for not making themselves aware of national standards and content benchmarks and, as a result, that they fail to appropriately challenge the thinking of students and promote science literacy. Indeed, it is all too easy to criticize teachers for focusing on rote memorization of science vocabulary and facts as opposed to fostering deep conceptual understanding and critical thinking skills. However, my sense is that we, as a science education community, must share their responsibility. Perhaps we fail to offer adequate preparation or ongoing support for teachers to enable them to do otherwise.

My Venture

In trying to resolve my vexation, I sense that I face at least three major obstacles. First, elementary teachers' knowledge of content is narrowed, in part, by a limited diet of science courses, although their background in science may be broader in the future as states increase the number of science courses required for high school graduation. Second, experience with preservice elementary teachers suggests that most individuals who select elementary education as their major have not previously enjoyed a strong affinity for science. Indeed, many describe predominantly negative science-related experiences. As a result, science methods courses often include a content component along with a focus on pedagogy. Nevertheless, a single methods course can accomplish only so much in strengthening candidates' conceptual understanding. Moreover, teachers are often unaware that their conceptual understanding is incomplete or flawed. Finally, teacher development opportunities for practicing teachers also tend to emphasize pedagogy, although science content is nearly always a component. However, elementary teachers often elect to concentrate their professional development efforts on literacy or mathematics (academic disciplines considered to be "core subjects"), particularly with recent accountability measures focused on these areas of the curriculum. (This, too, may change based on the inclusion of science as part of *No Child Left Behind* legislation.)

Despite these barriers, I envision a venture that has the potential to help resolve my dilemma: the development of professional support systems within schools and across school districts. Professional learning communities or communities of inquiry (Cohen & Hill, 2000; Dufour & Eaker, 1998; Hammerness et al., 2005) have been the focus of much recent conversation in education. Research suggests that communities in which "teachers share understandings about the nature of good teaching and work together to enact them" provide particularly favorable settings for teacher learning (Darling-Hammond et al., 2005, p. 404) and emphasize the potential power of communities of practice (see Wenger, 1998). Typically composed of educators within the same discipline or grade level, professional learning communities are designed to engage teachers in inquiry concerning questions of teaching, learning, and schooling.

I propose expanding the notion of a professional learning community to include teams of teachers at multiple grade levels across schools. I recall the wistful query of one of my fellow sixth grade teachers, voiced nearly eight years ago: "Wouldn't it be great if we had someone to ask when we don't understand the science behind what we are supposed to be teaching? Do you suppose it would ever be possible for us, as elementary teachers, to be paired somehow with a science teacher at the junior or senior high level to whom we could comfortably turn with questions?" Interestingly, I also recall a conversation with a local high school biology teacher. To my surprise, he suggested that it would likely benefit his students if he could spend time talking to and learning from "some elementary teachers" concerning the logistics of engaging his students in a "more active learning environment." Based on these and other conversations, my sense is that teachers at all levels can learn from each other. However, a number of structural and organizational constraints would need to be addressed in order to support a learning community composed of science educators at different levels. For example, districts would be required to facilitate the process of organizing groups, offering professional development credit, and structuring time for teams to work together within the regular school day. Initially, questions based on observed needs of teachers (e.g., elementary teachers' limited science content knowledge) may also come from the district. Then, when teams are organized and structures have been put in place to support collaboration, learning about teaching and subject matter could then develop through participation in a community of learners, where content is encountered in contexts in which it can be applied.