The Highly Qualified Teacher and Pedagogical Content Knowledge

The Issue:
National policy demands that all teachers meet the highly qualified standard with emphasis on demonstrating subject matter competency in science, but it de-emphasizes the importance of other domains of teacher knowledge, such as pedagogical content knowledge critical to successful teaching of K-20 science.

Background:
Science content knowledge is only one of many domains of teacher knowledge critical to teaching science effectively.

Cited in Examining Pedagogical Content Knowledge (Gess-Newsome & Lederman 1999), Lee Shulman (1987) states that pedagogical content knowledge (PCK) is one of seven knowledge domains for teaching. Among these domains are knowledge of content, general teaching strategies, curriculum, learners, educational settings, and aims of education. According to Shulman, PCK is a special combination of content and pedagogy that is uniquely constructed by teachers. It is the “special” form of an educator’s professional knowing and understanding.

It represents the blending of content and pedagogy into an understanding of how particular topics, problems, and issues are organized, represented, and adapted to the diverse interests and abilities of learners and presented for instruction. (Shulman, 1987, p. 8)

It is the transformation of 1) subject matter knowledge and 2) general pedagogical knowledge that is generally known as PCK. Others argue, however, that PCK is a separate category fueled by subject matter as well as pedagogical and educational context knowledge (Magnusson, Krajcik, Borko, 1999). Despite the lack of consensus, researchers agree that the unique qualities of PCK are important in understanding science teaching and science education.

Why do science teachers teach the way they do?
The National Science Education Standards (1996) state that increasing achievement for all students is best accomplished through better science teaching. Despite efforts at reform, however, science classes have remained virtually unchanged. Various permutations of the phrase “teachers teach as they were taught” echo throughout the research literature on science classroom practices. Thus, after 20-plus years of reform efforts, what we often see in a science classroom are the same traditional practices we experienced as students.

Traditional methods are not bad, but they are sorely overused. Nor is one teaching method any better than another, but there are limitations in relying on only one or two methods. Different methods serve different goals. Successful science teachers draw from a wealth of pedagogical strategies. Learning how to reflect upon the selection, planning, and orchestration of science content and pedagogy that can provide meaningful learning for students is the essence of pedagogical content knowledge.
Teaching is an innate ability: If you know the content, you can teach science. Student achievement has been shown to improve when teachers have strong content background (coursework and teaching experience) and pedagogical knowledge (e.g., hands-on inquiry, training in classroom practices, and wait time). Neither strong content nor strong pedagogical knowledge alone is adequate to increase student achievement substantially. Thus it is the teacher’s ability to transform his or her knowledge of the subject matter and pedagogical knowledge that is so crucial to student achievement.

Challenging the idea that teaching is an inborn quality, specific science teaching pedagogies are best acquired via mentoring, collaborating with colleagues, reflecting, and practicing. In order to change the way educators teach science, they must be given new experiences that enable them to learn to teach in different ways that may encompass a range of pedagogical methods that include inquiry, constructivism, 5E cycle, conceptual organizers, questioning, nature of science, cooperative learning, and authentic science laboratory investigations.

Impact of PCK on Developing and Practicing Science Teachers
Several studies have examined the practical connections of PCK to science instruction. A literature review by van Driel, Verloop, and de Vos (1998) found that teacher PCK “can be enhanced by intensive short term, skills-oriented workshops” and can generate change in teachers as a result of developing pedagogical content knowledge (Clermont et al. 1993, p. 41). Furthermore, through an empirical study, the researchers found that there is a potential value in having prospective teachers study subject matter from a teaching perspective. This and other studies (Lederman, N. & Chang, H., 1997; Smith, D.C., & Neale, D.C., 1989) have also shown the importance of PCK in teaching, especially science teaching.

Teachers need to observe, practice, and refine teaching pedagogies to master the skills required to deliver high-quality science teaching. As teachers’ pedagogical content knowledge expands (both in pedagogy and content), their ability to impact learning increases (McREL, 2001).

PCK and the NSES
Study of the NSES reveals that Standard one addresses content knowledge understandings and Standard five addresses the pedagogy of science teaching. While PCK is mentioned in Standard one, it is only briefly mentioned to explain that the content standard would be looking at the content-specific aspect of this construct. Other science educators, such as Enfield & Dugganhaus (see website in later section), argue that PCK is an essential tenet in the current thinking about science teacher education and should be included as more than a mere mention.

PCK as a pertinent element of thinking about science teaching is recognized in the content section of the NSES, which implicitly demonstrates how these two standards are inextricably linked when taken in context. For example, the pedagogy standard suggests that teachers know about "organization of classroom experiences" (National Science Teachers Association, 1998). To design such "organizations," however, requires a deep understanding of content. This is what Shulman (1987) is talking about when stating, "the key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy" (pg. 15). To have a set of standards that
implies that pedagogy takes precedent over content or vise versa seems to ignore much of the research.

Discussion Questions:
1. What are the essential elements of high-quality instruction in science?
2. Do we (or should we) consider PCK an essential part of instruction in science teacher education?
3. How does PCK fit (or not fit) into the NCLB/highly qualified teacher policy?
4. Is it sufficient to be highly qualified in a science content area to be a highly qualified teacher?

Pedagogical Content Knowledge in Science Websites:

http://www.msu.edu/~dugganha/PCK.htm (This site relates to the Standards.)

http://www.mcrel.org/PDF/EDThoughtsScience/6804IR_EDThoughtsScience_13.pdf (This is the pdf version of the article “How does teacher pedagogical knowledge affect science instruction?”)

http://www.ied.edu.hk/apfstt/v4_issue2/mulhall/mulhall5.htm (This site gives two different frameworks.)

http://www2.educ.sfu.ca/narstsite/publications/research/pck.htm (This site contains the article “Pedagogical Content Knowledge: Teachers’ Integration of Subject Matter, Pedagogy, Students, and Learning Environments.”)

http://www.sii.soe.umich.edu/documents/pck%20final%20report%20revised%20BR100901.pdf (This site deals with examining teacher pedagogical content knowledge.)

http://www.sv.ntnu.no/ped/sigrun/publikasjoner/values.html (This site offers an article about the value of PCK.)
References


