

Vision & Reality: Sustaining Teacher Change

I often feel out of step with the science education community. When I'm with science education researchers, I feel inadequate: I don't produce the steady stream of publications. When I'm with science teacher educators, I feel idealistic: my work in science education reform seems impractical compared to a good, practical methods class. When I'm with science teachers, I feel like I'm speaking a different language: my talk about an inquiry-based, constructivist classroom must sound to them like Charlie Brown's mother: "Wah-wah, wah-wah, wah-wah."

And yet, I persist. I believe in science education reform. I'm committed to the new vision for teaching and learning science, a vision grounded in research and visionary for preparing students for life and work in a modern society. Furthermore, I've had the privilege of teaching inquiry to high school students and seeing it really work.

Success:

I see the vision of the national standards beginning to be realized. I believe that we've been successful in beginning to create a common vision for science teaching and learning in the form of science literacy and inquiry. I also believe that we have research-based solutions in teaching for conceptual change and exemplary curricula.

Science literacy is the right goal for science education. After years of deprogramming my old ways of thinking, I really do believe that all students can learn. Since this is true, we need a different curricular goal for science teaching. The traditional paradigm for science teaching focuses on the teaching the best and the brightest students so that they can become scientists. Science literacy gives us broader and more moral goal of teaching in ways that all students learn the science that will engage them now and benefit them in their adult lives. Science literacy has a clear definition in national reform documents, the most user-friendly of which is *Atlas for Science Literacy*.

Inquiry is the right mode for science teaching. In contrast to traditional, lecture-based approaches to science, inquiry-based science engages students in hands-on experiences and develops in them the heads-on understanding of science phenomena. I've seen inquiry work with my high-school students and with the students of teachers I've worked with in several different places across the U.S. Inquiry has a clear definition in chapter 2 of *Inquiry and the National Science Education Standards*.

Student misconceptions are real, and teaching for conceptual change is a pedagogical model effective for guiding students to abandon their misconceptions and anchor their thinking in more scientific understandings. We have clear research on both of these. In my methods classes, I've guided practicing science teachers to face the misconceptions that persist in their students' minds after those teachers have, according to their beliefs, taught well. This is a powerful and disturbing experience for teachers, and it makes them question traditional teaching practices. Effective models for conceptual change teaching have emerged, and we have enough insight in this area to offer teachers effective models they can use in their classrooms.

Exemplary science curriculum exists and these curricula give teachers tracks to run on as they implement science literacy, inquiry, and conceptual change teaching in their classrooms. Via the work of the National Science Foundation, we have K-12 curricula field-tested for sequences of

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learning experiences proven to cause students to learn. Some examples of these curricula are FOSS, Insights, and STC at elementary and middle school levels, and Active Physics, Earth Comm, and Insights for Biology at the high school level.

My Vexation:

I have full confidence that the above models combine to make for a powerful science classroom where students really learn, but I can't figure out how to sustain science teachers in a move toward reformed practices. I've figured some ways to get them begin the move, but I don't see success in keeping them moving, especially when they're on their own away from me, the university, or reform projects.

I used to think the standards would cause teachers to change. For a time in my career, I centered my practice as a teacher educator on introducing teachers to the standards, thinking that they would then be invested in standards-based practices. I had caught the vision; I figured they would, too. They pondered the standards; they argued the standards; some even loved the standards. Later, though, I saw very little in most of these teachers to indicate that they had shifted their practice to standards-based methods.

I used to think student misconceptions would cause teachers to change. I've seen that powerful moment in my methods courses when teachers realized that their own students were retaining misconceptions after instruction. I was confident that I had provided a powerful discrepant event about teaching itself that would cause teachers to abandon their traditional beliefs. Now, though, I meet those teachers years later, and as they talk, I realize that most of them haven't changed.

Currently, I'm trying a suite of approaches. A single approach like standards or conceptual change didn't seem to work; so, I've decided that I need to guide teachers to wrestle with multiple issues at once. Can't they see that a curriculum focused on science literacy, delivered through inquiry, incorporating conceptual change, and engaging students will result in true student learning? My first feedback with this approach seems to say that it doesn't work either. It's too complex. It's overwhelming, especially for traditional teachers who work in traditional teaching cultures.

I'm confused and even discouraged at times. So much of what I think I know should make for a better world for teachers and students. I truly believe that the lives of students, and their teachers, will be enriched by these approaches. Other than just a few, however, I can't seem to get teachers moving toward these answers. Perhaps I'm totally wrong. What I think to be answers may be actually ivory-tower mirages that will never work in real classrooms. Perhaps I'm too impatient. These things I believe are answers, but they will take decades of reform to implement on a large scale.

I look forward to the prospect of receiving insight from my colleagues at Crossroads. My questions are beyond head questions. They are becoming issues of my soul. Am I doing something worthwhile as a teacher of teachers, or am I wasting my time and theirs?