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Nature-of-Science (NOS) Instruction and the Politics of Science

Successes

One of the most important successes in science education in the past few decades has been the widespread recognition of the need for adequate instruction about the nature of science (NOS). This growing concern has not only evidenced itself in the inclusion of NOS as a central organizing theme in various national standards documents adopted in different countries across the globe but also in increased concern that the U.S. is losing its position as the world's leader in science and in the preparation of scientists who will lead the field in the future. Officials at universities in Kansas have reported, for example, increasing difficulty in attracting quality candidates for science faculty positions since the recent battles over evolution and the nature of science in the state science curriculum began because candidates increasingly view Kansas as backward. The message seems clear that instead of somehow returning the "teaching the basics," science curricula must somehow provide students with an understanding of science that prepares them to be competent members of modern society.

Although NOS instruction has been called for repeatedly over at least the past century, the development of effective instruction was stymied by at least two facts. First, there was no consensus about exactly WHAT nature of science or WHOSE nature of science was to be taught. The so-called "demarcation question" had "tied philosophers in knots. Second, science educator researchers felt paralyzed by this quandary—What set of characteristics should we teach? Which philosopher's views were right? How could we possibly know what to teach (much less HOW to teach it), if "no one agrees" on what NOS to teach? A survey by Alters (1997) that revealed great disparity in philosophers' views of the NOS was crippling. Questions about our responsibility to accommodate and even teach non-Western views of science and the "science" of more primitive cultures were also raised.

A diverse group of five science educators (Smith, et al, 1997) responded to Alters, however, by asking the critical question of whether the level of philosophical sophistication at the heart of this diversity was relevant to instruction at the introductory level—at the level appropriate for non-philosophers. They also asked whether or not there was, in fact, a general consensus among science educators about the tenets of NOS that would be required for citizens that should be taught. Following that exchange, the science education community has indeed come to a general agreement about the tenets of NOS that should be taught. Lists of these characteristics are to be found in the writings of Lederman, Abd-El-Khalick, Akerson, McComas, Clough, Scharmann, and others, including myself.

Another success of science education has been identifying successful approaches to NOS instruction. These methods share several common features. First, effective methods for teaching the nature of science are explicit, i.e., the nature of science, its characteristics, and distinctions between science and non-science are explicitly addressed. Second, effective NOS instructional methods \ have been based on constructivist/active learning precepts that include student reflection with explicit feedback. A third feature of effective NOS instruction is that it plans for and is respectful of the prior conceptions and personal beliefs that students may hold. NOS instruction often occurs in the context of teaching evolution. Even when this is not the case, the issues of evolution, creationism and intelligent design often arise in the discussion. Too often, in such instruction of the past, instructors have simply presented what they view as "the facts" and told students that hold opposing views that they are simply wrong. If they are to embrace science in any form, they are told that they must reject their worldviews. Needless to say, such an approach is not only inappropriate, but also ineffective.

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Vexation

At a job interview many years ago, a faculty member asked me to identify five research studies that led to specific things that teachers should do to improve science learning. I had great difficulty answering that question, and I have thought about that experience often. I am not so sure I would do an appreciably better job of responding today. The phenomenon that raises my ire the most these days, however, is the triumph of politics over science, including recurrent political threats to the teaching of evolutionary principles. Examples abound, but three that vex me the most are the federal government's support of abstinence-only-until-marriage sex education programs of questionable merit to the detriment of funding for scientifically based programs of proven effectiveness, the federal government's refusal to support needle-exchange programs for HIV prevention based solely on moral/religious grounds, and the never-ending misguided attempts in various political venues to oppose the teaching of evolution and to include religious arguments in public high school biology classes. All three issues relate directly to my own work, but the most relevant here is clearly the third.

Opposition to the teaching of evolution is, of course, long-standing, and the battles are current. Far too many teachers in the U.S. are afraid to become lighting rods for the vitriol that typically accompanies these arguments and find it easier simply to avoid "the E word." Similarly, many teachers clearly do not have the expertise required—either in evolution or in the NOS—to provide effective instruction in evolution. A pragmatic approach that Larry Scharmann and I advocated in NOS/evolution instruction is to allow students to view science/non-science not as a discrete dichotomy but as a continuum, giving them "a place to stand." We have also found it effective to use Kuhn's methods of ostention in which students judge pairs of example claims or fields of study as more or less scientific, using those distinctions to generate the contrasting characteristics of science and non-science themselves. As much as we may hate to admit it, however, now that effective methods for instruction in NOS and evolution are being developed, the next task that must be engaged is political. We must find ways to address the legitimate concerns of religious conservatives as well as ways to promote this instruction that are not seen as threatening to conservative beliefs. One of the ways I see to approach the latter (as I have written elsewhere with Harvey Siegel) is to explicitly affirm that the primary goal of science education is to develop scientific UNDERSTANDING, not change beliefs about the supernatural.

- What can we do make science education research more PRACTICAL, i.e., have a larger impact on classroom instruction? Would it be a good idea to convene groups of teachers to find out what THEIR questions about instruction are? How can we encourage researchers (even doctoral students) to find these questions worthwhile? What innovative ways can we find in this electronic age to communicate the implications of research to teachers who could benefit from them? Can anything be done as long as high stakes testing rewards rote memorization?
- Can we identify ways to encourage the two political sides of the evolution/special creation debate (in its various forms) to actually listen to each other, not just argue ad infinitum? Is there a way to couch the issues in language that does not disenfranchise one side or the other? What concrete actions can we take to help state and federal education officers and policy makers recognize that a proper understanding of the NOS does not require the rejection of religious beliefs—at least those of most denominations?
- Is it feasible to propose that we can actually prepare secondary (and even elementary?) science teachers with an adequate conceptual understanding of the nature of science? Might this require that we collaborate with teachers in the science (and even philosophy) departments?