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# Faith-based Evolution Education?

ROSS H. NEHM

**S**cientists nationwide breathed a collective sigh of relief after a federal judge barred a Pennsylvania public school district from teaching intelligent design (ID) in biology classrooms. Unfortunately, although a battle has been won, the war rages on. More than 19 other states and school districts have antievolution initiatives under consideration. Gallup polls and research studies remain in clear agreement: Americans' acceptance and understanding of evolution are low and have remained unchanged for decades. Perhaps of even more concern is that science teachers themselves reject evolutionary theory in frighteningly large numbers.

It is time for scientists and science educators to take a good look in the mirror. Despite our legal successes, we have failed to help the public understand why evolution is central to our understanding of everything from AIDS to ancient life. The important question, of course, is why we fail. The answer, I argue, is belief. But it is not only the deep-seated beliefs of creationists and ID supporters that explain our failure. It is the beliefs of scientists themselves as they attempt to deal with this national educational crisis.

Scientists from disciplines as diverse as physics and paleontology have spent thousands of hours chronicling their beliefs about the problems of creationism and ID in numerous books and articles. These beliefs are valuable because beliefs—like guesses, hunches, intuition, and anecdotal experiences—can be genuine sources of guidance and direction in scientific research, whether we like to recognize this explicitly or not. But perhaps scientists' time and effort would be better spent doing what we do best—being scientific. Rather than disseminating our beliefs about the problem, we should be delineating core questions that can be investigated empirically, con-

structing validated instruments for meaningfully measuring evolutionary knowledge, rigorously evaluating the reliability of prior conclusions, and replicating quasi-experimental research studies on diverse samples of learners (NRC 2005).

But going down this alternative scientific path is difficult, because research on teaching and learning is not what chemists, physicists, biologists, and geologists have been trained to do. In an age of standards-based assessments throughout the educational hierarchy, it is ironic that the faculty receives little (if any) formal education about teaching, learning, or assessment. Many scientists involved in education are unaware of education basics such as criterion-related validity, student response reliability, or self-selection and performance biases. Scientists' unfamiliarity with these topics—combined with confusion about the thornier issues of belief, acceptance, knowledge, and personal epistemology, which are of central importance in understanding antievolutionary worldviews—have left many searching for their bearings in foreign academic territory. So when scientists decide to start being scientific about the evolution education crisis, they will be faced with the recognition that they can't solve this problem by themselves. To whom, then, should they turn for direction?

The profound lack of interaction, mutual respect, and collaboration between many scientists and science educators in the academy, in addition to the growing technical research literature in science education, has resulted in deep isolation between these two disciplines. Unfortunately, scientists who have little familiarity with the burgeoning education research literature, or with educational research methodologies in general, have charged forth in multiple directions while ignoring much of the educational

groundwork that has already been laid by science educators. Reinventing the educational wheel may produce novel insights into the problem, but presumably it would be more productive for scientists and science educators to join forces and attack the problem using the knowledge that we already possess—knowledge about how to begin to forge more rigorous approaches to gathering data about the roots of the problem and evaluating different educational interventions.

Unfortunately, many scientists seem to believe that they know the problems that we face and how to solve them. In the past year I have attended three national scientific symposia on evolution education in which no education faculty served as panelists or participated as invited speakers. Perhaps more remarkably, at these scientific conferences no data relating to the problem of antievolutionism were included in any of the presentations, and no attendees bothered to ask the speakers what evidence supported their conclusions. Many interesting and reasonable talks were presented, but none were scientific in any sense of the word, and none made reference to any of the research literature in science education. Why are data so peripheral to this national discussion about science? Why are scientists so ready to divulge their untested beliefs instead of seeking the evidence that they demand in their native disciplines?

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The question of whether we should proceed using faith or science as our guide in the evolution education crisis is important. At a fundamental level, we need to decide how the hundreds of thousands of federal dollars earmarked for evolution education should be spent. Much of the money has been devoted to developing and disseminating curricula, crafting position statements, holding workshops, providing teacher professional development, training museum docents, and building museum exhibits. Such spending seems at first glance to be quite reasonable. But many, and perhaps most, of these curricula and workshops are like castles built on sand—we simply do not have adequate justification for what we are doing or rigorous data showing that these approaches work.

If we hope to improve evolution education in the United States, we will need to value and promote high-quality scientific research (NRC 2005). Our knowledge base on evolution education is best developed in the realm of student misconceptions or prior knowledge (Duit 2006). An extensive, replicated body of knowledge documents the key problems that students of many different ages have in understanding evolution. But this is where our high-quality knowledge base ends. Regardless of one's educational training, perusing the evolution education literature with a skeptical eye and a critical mind will quickly reveal that much of what we know does not meet the criteria set forth by the National Research Council or the standards for high-quality scientific research in general. The vast majority of the 200 studies on evolution education that I reviewed—by no means an exhaustive survey—cannot be considered high-quality because of (a) re-

markably small sample sizes ( $n < 30$ ), (b) self-selected groups of participants, (c) the absence of reliability data, (d) the use of instruments lacking validation, (e) unrealistic intervention durations (one week or less), (f) the lack of comparison or control groups, and (g) partial intervention descriptions prohibiting replication. Several studies lack pre-intervention data but conclude that their approach was successful. Although some of these weaknesses could be forgiven if a study were successfully replicated, only one of the studies that I reviewed was ever replicated, and in this case different results were found (Demastes et al. 1995).

How might we begin to change this situation and build a high-quality scientific foundation for evolution education? Our first and most obvious need is a rigorously validated and reliable instrument for measuring evolutionary knowledge in students of different ages and educational backgrounds. As anyone involved in assessment knows, testing students is much more complex than it first appears. Unfortunately, only one weakly validated instrument for measuring evolution knowledge in college nonmajors has been developed, and it remains in need of replication (Anderson et al. 2002). Second, we need to evaluate and replicate the pedagogical interventions espoused by some as beneficial (Alters and Nelson 2002) relative to control or comparison groups with sufficient sample sizes. A review of the evolution education literature demonstrates that only a handful of such studies exists. Finally, we need to perform a randomized nationwide study to establish a baseline of evolutionary knowledge at different levels in the educational hierarchy, so that after we complete and implement evidence-based

interventions we can effectively measure potential progress. Simply put, if we don't have a validated instrument for measuring evolutionary knowledge in the first place, and lack comparative studies using control groups or sufficient sample sizes, how can we come to any meaningful conclusions about what we should be doing?

As a result of our splintered, discipline-bound, and faith-based approaches to addressing the evolution education crisis, scientists and science educators have made remarkably little progress. It is time to envision a new era of evidence-based evolution education research and abandon our beliefs about both the problems and the solutions to this national crisis. The time has come for science to be brought to bear on this scientific problem (NRC 2005). For that to happen, scientists and science educators will need to join forces once and for all.

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