

Making Sense of Darwin for Nonmajors: Strategies to Increase Understanding and Acceptance of Evolution

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Despite 20 years of intense focus on science in public schools, US citizens continue to demonstrate a low level of science literacy. In 1998, a poll conducted by the National Science Foundation showed that more than 50% of American adults believed that the sun orbits the earth. An A.C. Nielsen poll taken in 2007 found that 13% of adults have never heard of global warming. A NASA administrator was shocked when a funding request was challenged with the question: "Why do we need meteorological satellites when we have the Weather Channel?"

An appallingly low level of knowledge also is evident in students entering science classes at OSU. For instance, in a 2005 survey of 700 students enrolled in Biology 101, 55% believed that they were direct descendents of Adam and Eve who lived in the Garden of Eden about 4000 years ago. A subset of these students believed that dinosaurs and humans co-existed (the so-called "Fred Flintstone" view of paleontology and human origins). This view is likely to gain prominence with The Creationism Museum in Kentucky teaching that *Tyrannosaurus rex* used to be a vegetarian until Eve ate the apple at which point *T. rex* converted to carnivory.

While public understanding of science is low in all areas of science, the public's ignorance of evolution is arguably the most disturbing. In the modern world, scientific advances in medicine, agriculture, biotechnology, genomics and conservation biology, to name a few affected fields, are intimately tied to evolution. If citizens are to understand and make intelligent, informed decisions about issues arising in these areas, they must have a basic understanding of evolution. Since the very idea of an evolutionary explanation of how organisms change over time is offensive to many people with fundamentalist religious views, providing instruction about evolution to such people in public schools will do little to change their understanding of how

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the world works. Even a discussion of science and religion can be a recipe for disaster as our polarized and often vitriolic public discourse demonstrates. But why is it so angry? If we fail to understand the differences between science and religion, if we ask one to do the work of the other, we invite precisely the sort of recrimination that we now see in our public conversations. Although important thinkers such as

Stephen Jay Gould have argued that science and faith are compatible only insofar as they occupy "separate and non-overlapping magisteria", an emerging area of research suggests that actively engaging the issue of the apparent conflict between evolution and religious values may be the most effective way of changing people's views. In other words, the time has come to acknowledge both elephants in the living room and let their presence inspire and teach us. The trick is to find a way to honor both science and religion for what they truly are, while finding a way to dispel misconceptions about the nature of both.

With this in mind, I developed a series of three strategies for helping my Biology 101 students explore the nexus of evolution and religion during autumn quarter of 2006. A revised lecture on Charles Darwin comprised the first strategy. In addition to conveying traditional information on natural selection, the revised lecture contained historical information about the important thinkers who influenced Darwin (Lyell, Paley, Malthus, Wallace). In addition, the revised lecture covered reaction to the publication of the *Origin of Species*, Darwin's seminal work, in both scientific and religious communities. The purpose of this strategy was to set to context for understanding the evidence for evolution and to demonstrate why the theory of evolution is considered settled science, having repeatedly been confirmed through hypothesis testing in disparate fields. We also hoped to humanize Darwin and show the reasoning that led him to the theory of evolution by natural selection.

The second strategy involved inviting 3 laboratory sections of Biology 101 (24 students per section) to engage in a facilitated discussion of what should be taught in biology class and who should decide what is

taught. The conversations were recorded at WOSU-TV studios for later analysis. The purpose of this strategy was to allow students to articulate their own views and, using the facilitator, to probe the foundation for those views and how malleable their views might be. We also wanted to give students experience in having civil conversations about controversial issues.

Finally, the third strategy consisted of inviting 4 eminent scholars to OSU to participate in a panel discussion about how evolution and religion can be reconciled. In 2006, these scholars were: John Haught (Professor of Theology, Georgetown University); Edward Larson (Professor of Law and History, University of Georgia); Owen Gingerich (Professor of Astronomy and History of Science, Harvard University); Holmes Rolston (Professor of Philosophy, Colorado State University). Students were required to attend the panel discussion and to write a 5-page paper in which they answered the following questions:

1. Describe the extreme positions on the evolution/religion spectrum (atheism vs. Biblical literalism);
2. Explain how the extremes might be reconciled using information gleaned from the panelists.

The rationale of this strategy was to expose students to the views of these scholars and to help students see that these two world views need not be in conflict.

In order to evaluate the effectiveness of these strategies in enhancing understanding of evolution and increasing acceptance, we obtained IRB approval to collect data from the students. Of the 700 students in the class, 317 signed the consent form allowing us to collect data and complete all of the evaluations. The latter included a standardized test for measuring acceptance of evolution that was administered during the first week of class and again at the end of the course. In addition, a subjective analysis of student opinion was performed by analyzing the tapes made in WOSU-TV studios and reading student papers based on the evolution and religion panel discussion.

Analysis of the standardized test for assessing understanding and acceptance of evolution showed a highly significant increase in mean score comparing pre- and post- tests (3.6 (pre)- 3.9 (post), N= 317, sign.

0.000). While the significant increase in acceptance of evolution was gratifying, the numerical difference in the mean score for the test given at the beginning of the course and again at the end of the course was quite small. I attribute the significant difference to the very large sample size with which we were working. The small change in mean score indicates that student attitudes about evolution are resistant to change, a finding that is consistent with the existing literature on the subject.

The facilitated discussions that occurred in WOSU-TV studios provided insight into some of the reasons why student views on evolution are recalcitrant. Interestingly, students who identified themselves as Catholic were most accepting of evolution and failed to understand why there is a controversy. However, it is also clear from their comments that evolution and religion did occupy the "separate and nonoverlapping magisteria" that Gould described. One wonders whether evolution or religion would prevail if students were forced to confront an issue that straddles both worlds.

It was also clear from student comments that there is a profound lack of understanding of what science is. For instance, students repeatedly made comments to the effect that "evolution is just a theory" despite having been given a lecture on the scientific method, having watched a video, starring Jim Tressel, that explains the difference between hypothesis and theory and having been tested on the material twice. The tapes showed that students have not processed and internalized the epistemological information given to them in class—material that is also a large part of K-12 science curricula. While it is disconcerting to find that students do not make a distinction between information derived from the testing of falsifiable hypotheses (science) and beliefs that come from the authority of divine texts (religion), this information also provides teachers with a direction forward. Specifically, teachers need to provide more exercises, preferably interactive, on the nature of science. This, of course, can be done in all scientific disciplines, not just those with an evolutionary underpinning. These findings also suggest that students need actual experience in developing and testing hypotheses. It is not sufficient to hand students a step by step recipe as a laboratory experience and expect that they will learn how science is done. The current push to provide a laboratory research experience as part of an undergraduate education is a salutary development and it should be extended to K-12 classrooms as well. Only when students have a fundamental understanding of how scientific evidence is produced, what it means for a hypothesis to be

falsifiable and how science is self-correcting, can we expect to make significant progress in understanding and accepting evolution.

The panel discussion on Science and Religion in the Age of Darwin took place in Fawcett Center Auditorium. Approximately 350 students attended the live event while the rest of the students watched the panel discussion on DVD. Many students felt that the experience was valuable. In fact, one student commented that hearing the panel discussion was one of the two or three most meaningful experiences he had had while at OSU. Other students felt aggrieved by having to write a paper although they did not feel that the topic was inappropriate or without value. More importantly, the same lack of understanding detected in the WOSU-TV tapes about science was very much in evidence in the student papers. However, it wasn't just science that was a mystery. Even students who professed deeply held belief in a particular faith, frequently had mistaken ideas about the tenets of their faith suggesting there is work to be done on this side of the ledger as well.

The research conducted thus far suggests two things: that progress in getting students to understand and accept evolution can be made most effectively by doing a better job of teaching them about the nature of science and; multiple approaches to teaching evolution are needed to enhance understanding and acceptance. On the strength of these initial findings, I have changed the Biology 101 course syllabus to emphasize material on the nature of science and the IRB has been revised to allow additional testing and evaluation of student understanding. Finally, I have obtained a five year grant from the Templeton Foundation to continue panel discussions for Biology 101 students. Working in collaboration with COSI and WOSU-TV, our goal is to help not only undergraduate nonmajors at OSU make sense of Darwin but to make some progress in scientific literacy among the general public.