Learning the Nature of Science

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Learning the Nature of Science

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Media headlines question scientists' concerns about global warming. Magazines advertise weight loss products—results guaranteed. Web-based articles and best-selling books explain the evolution of species as "intelligent design" creationism. Students are bombarded daily with claims backed by "scientific research," but where do they obtain the skills and knowledge necessary to distinguish science from pseudoscience?

Students learn about "science as a human endeavor" and the "nature of scientific knowledge" and gain "historical perspectives" throughout their elementary and secondary school education, according to the National Research Council's *National Science Education Standards (www.nap.edu/catalog/4962.html)*. The undergraduate introductory biology classroom provides an excellent venue in which to reinforce and extend these concepts. For many students, this may be their last formal science training before they join the ranks of the scientifically literate, lifelong-learning citizenry.

Professors may assume that students gain an understanding of the nature of science and scientific inquiry simply by conducting experiments or fieldwork, but education research shows otherwise. Norman G. Lederman, chair of the Department of Mathematics and Science Education at the Illinois Institute of Technology, has been conducting research for more than 20 years on teaching the nature of science. "Conceptions of nature of science are best learned through explicit, reflective instruction," states Lederman. Professors need to make a conscious, deliberate effort to ensure that students learn about the nature of science and scientific inquiry.

History offers an effective lens through which to view human endeavors. David Rudge, professor at Western Michigan University's Department of Biological Sciences and the Mallinson Institute for Science Education, uses examples from the history of biology to illustrate the nature of science to his students. "We invite students to explore problems which are simplified but similar to those encountered by scientists in the past," says Rudge.

Sickle-cell anemia, for example, provides an excellent mystery for students to unravel through open-ended, problem-based activities. Students investigate the disease through a historical perspective, viewing the data as they became available over time to research scientists. As the instructor adds new information, such as geographical distribution data or the connection of heterozygosity to malaria resistance, the students gather evidence to solve the mystery. Along the way, students identify their own misconceptions, which are often similar to those held by past scientists. "It is our hope," says Rudge, "that by undergoing a similar set of experiences, students may undergo a similar sort of conversion in their thought about the phenomenon."

Rugde's classes actively discuss the limitations of these experiments, the way they are represented in textbooks, and the dead ends and risks that scientists faced. In this way, students see how science changes as new information is discovered, and they also learn what can or cannot be answered through science.

Steve Rissing, professor in the Department of Evolution, Ecology, and Organismal Biology at The Ohio State University, says he no longer tries to "teach his students everything there is to know" about biology in his introductory courses. Rather, he facilitates connections between biology and students' lives and helps them learn how science differs from other ways of knowing. "My program has gone pretty far in the direction of explaining to students in ultra-large lecture [and] lab courses the underlying nature of the science they are doing," says Rissing.

His students explore questions such as "What is global warming and why care?" and "Why do we get sick?" They read articles in current news media on issues such as fetal genetic defect testing. Because these topics are relevant to their lives, students become engaged in the process of learning biological content as they look for answers and investigate the dilemmas. Rissing specifically takes the time to discuss the science methods, history, conflicts, and ethics involved in each story, preparing his students for the types of real-world questions and issues they will encounter throughout their lives.

Lederman suggests that professors examine their courses and identify where the nature of science can be explicitly discussed during the lectures or labs.

Although some professors may feel that discussing the nature of science would give them less time to cover biological content, today's introductory biology students are tomorrow's teachers and parents, decision-makers, politicians, and world leaders. It is essential that they understand how science is distinct from religious, cultural, philosophical, or other ways in which we address questions about the world. Students need to hone their ability to distinguish science-based information from that which is not grounded in scientific research, so that they can make informed decisions about matters that affect not only their own personal lives but all living things.

Nature of Science Teaching Resources

- National Academy Press: Teaching about Evolution and the Nature of Science
  www.nap.edu/readingroom/books/evolution98/contents.html
- PBS Evolution: What Is the Nature of Science?
  www.pbs.org/wgbh/evolution/educators/course/session1
- AIBS Education: Resources for Teaching Biology
  www.aibs.org/education/teaching_resources.html

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