

New resource for teachers, public on how to recognize science when you see it

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If you think you know what science is and how science works, think again. A new University of California, Berkeley, Web site called "Understanding Science" (<http://undsci.berkeley.edu/>) paints an entirely new picture of what science is and how science is done, showing it to be a dynamic and creative process rather than the linear - and frequently boring - process depicted in most textbooks.

Funded by the National Science Foundation as a resource for teachers and the public, the material was vetted by historians and philosophers of science as well as by K-12 teachers and scientists.

"Through this collaborative project, we hope to overturn the paradigm of how science is presented in our classrooms," said Roy Caldwell, a UC Berkeley professor of integrative biology who led the project along with colleague David Lindberg. "The Web site presents, not the rigid scientific method, but how science really works, including its creative and often unpredictable nature, which is more engaging to students and far less intimidating to those teachers who are less secure in their science."

"Part of the fun of science is lost when you present it as a linear thing," said Natalie Kuldell, an instructor in biological engineering at the Massachusetts Institute of Technology (MIT) and one of 18 scientific advisors for the project. While the five-step process described in textbooks - ask a question, form an hypothesis, conduct an experiment, collect data and draw a conclusion - isn't wrong, "it is an

oversimplification," she said.

The core idea, said Judy Scotchmoor, assistant director of the UC Museum of Paleontology at UC Berkeley and coordinator of Understanding Science, is that science is about exploring, asking questions and testing ideas. The site provides a Science Checklist that can be used to determine just how "scientific" particular activities are.

Scotchmoor will discuss the Understanding Science approach at a Friday, Feb. 13, session celebrating the Year of Science 2009.

"The goal was to present (the concept) that testable ideas are right at the center of science, and if you don't generate testable ideas, then you are really not doing science," Kuldell said.

Testing, however, is intertwined with exploration and discovery - the "cowboy" aspect of science, in the words of one project advisor - review of hypotheses and theories by skeptical peers, and actual application of the science to real world problems.

Within the Web site, personal stories contributed by top scientists around the country illustrate the interplay of exploration, peer review and outcomes, and demonstrate the different pathways to discovery taken in different fields of science, from biology to cosmology.

Scotchmoor hopes that the site will show students and the public that "science really is an adventure. There are certain rules that you need to follow, but really you can't predict where questions will take you."

The Web site premiered on Jan. 5 during the launch of Year of Science 2009, and received rave reviews from New York Times science writer Carl Zimmer, who referred to it in his blog as "a guided tour through the basic questions of what science is and how it works." He particularly

praised the Process of Science flowchart illustrating how science works. A set of four interlocking circles represent the interplay between hypothesis testing and the ways scientists generate these hypotheses, while multiple arrows connect the circles to illustrate the roundabout way scientists make their discoveries.

"At best, I think, stories about science can only be snapshots of small patches of science's cycles within cycles," Zimmer wrote of the flowchart. "It (story telling) uses the one-dimensional medium of language to gesture towards science's mind-boggling multidimensionality. This picture from Understanding Science will help me remember to make that gesture, long after the Year of Science is over."

Four years ago, Scotchmoor, Caldwell and Lindberg created a Web site called Understanding Evolution that now provides a much-needed resource for teachers and the public.

"We discovered, however, that there was a lot of confusion about what science is and isn't," Scotchmoor said.

"Teachers had misconceptions, such as what a theory is or whether creationism is science," Caldwell said. "Many even thought science wasn't creative, in part because of cookbook labs, in part because of the emphasis on testing factual knowledge, not process."

With advice and input from historians, philosophers, teachers and scientists, Scotchmoor, Caldwell and Lindberg constructed the Web site from scratch, modeling it after Understanding Evolution. Understanding Science has been endorsed by the California Science Teacher's Association and the American Institute of Biological Sciences, and will be part of the next edition of a popular high school biology textbook, "Biology" (Prentice Hall), by Ken Miller and Joe Levine.

Kuldell uses it in her second- and third-year college lab courses to "set the expectations of my students, (to show them) that science is iterative and messy and doesn't always make a clean story - and that that should be expected. You work and then you rework, you get feedback, you rethink your ideas, and then retest. Science isn't quite as neat as people wish it were and think it should be."

The Web site will continue to grow, with personal profiles of scientists and their research, each accompanied by a flow chart showing how they proceeded from ideas to discovery.

Source: University of California - Berkeley

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