## Innovation and Inspiration in Education

THANK YOU, *SCIENCE*, FOR FOCUSING A special issue on Trends in Undergraduate Education (31 Aug.). Undergraduate science education is all too often the neglected child in colleges and universities. Their heavy focus on research often overshadows their teaching missions.

Praise should go to those organizations trying to raise the quality of teaching. Prime among these has been the Howard Hughes Medical Institute (HHMI). Over the past decade, a multitude of HHMI-supported efforts at Yale and other institutions have seeded courses and programs that emphasize small group discussions, closely supervised original research, innovative laboratory exercises, problem-solving approaches to learning, and the establishment of close mentoring relationships in the classroom and in the laboratory.

Two articles in the special issue refer to HHMI-supported programs for undergraduate education, but ironically, in "Reintroducing the intro course" (p. 1608), Erik Stokstad suggests that these programs "haven't produced any breakthroughs," and in "Making room for diversity makes sense"(p. 1611), Camille Mojica Rey says that "The Yale [and other] programs are also trying to spell out what they have done so that other schools can replicate their success." What is omitted from Rey's article is that the Yale and Berkeley programs are supported by HHMI.

"Breakthroughs" are in the eye of the beholder, but success can be measured. HHMI-supported programs at Yale have improved grades and markedly increased retention in the sciences. For example, independent statistical analysis showed that among the many factors influencing persistence of underrepresented minorities in science, participation in the Science, Technology and Research Scholars (STARS) program was the most influential factor. Data documenting many more stories of success (and failure) can be found on the HHMI Web site (www.hhmi.org).

Probably there is no magic bullet in education. Socrates said, "Education is not the filling of a vessel, but the lighting of a flame." Those who work in the trenches know that it is both. Flexible programs, like HHMI's, allow each instructor to create a unique starburst from the mix of his or her match with each student's individual candle.

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**Innovation**—The STARS program at Yale, with the help of professors like Iona Black (left), has succeeded in retaining minority students in science. **And inspiration**—It comes not "from the facts or principles taught, but from the contact with someone who is in love with the subject...."



REFORM MOVEMENTS IN UNDERGRADUATE science education have made great strides with well-spent investment from HHMI, the National Science Foundation (NSF), the National Institutes of Health, Fund for the Improvement of Postsecondary Education, and many private foundations. HHMI and NSF initiatives have made "Science for All Americans" more than just a slogan; they have begun to shape the ways that our education leaders think about future scientists and a scientifically literate public.

Although reform movements are presented as if they are hothouse blooms ("Reintroducing the intro course" by E. Stokstad, 31 Aug., p.1608), large-scale, long-term successes are not documented. For example, funds from HHMI, NSF, and Annenberg/CPB have enabled the BioQUEST Curriculum Consortium to have a major relationship with 150 colleges and universities, to impact 500 courses in other colleges and universities, to involve more than 6000 professors in workshops, and, consequently, to affect hundreds of thousands of students. Reform in biology, chemistry, mathematics, and physics has reached beyond reformers and innovators to achieve substantial institutional change and broad experiments in learning.

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LECTURING IS DESCRIBED AS "THE STALEST form of pedagogy" by E. Stokstad in his News article "Reintroducing the intro course" (31 Aug., p. 1608). However, in his discussion of alternatives, one word was missing—inspiration. An informal survey of my senior colleagues revealed that many of their undergraduate lecturers were forgettable, but two or three changed their lives—often through inspirational lectures.

The inspiration that comes from a great lecturer does not stem from the facts or principles taught, but from the contact with someone who is in love with the subject and can share that enthusiasm with the audience. Before abandoning the lecture format to the more expensive and time-consuming and less inspirational alternatives, might we not consider first improving the lecturing skills of our instructors? Better training of graduate students and better supervision of new lecturers would produce enormous benefit at little cost. A few simple technologies—stage lighting and projection television—would allow people in the back rows to have just as good a view of the instructor as those in the front seats. The Socratic method of teaching by asking questions can be used just as easily in a lecture hall as in a seminar room if the lecturer is trained in its use. Educational technology is valuable when it enhances the ability of an inspirational teacher to reach more students. When it becomes a substitute for that in-the-flesh contact, something important is lost.

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IN HIS REFERENCE TO A MEETING OF SOME research university department heads on the subject of the introductory course, E. Stokstad makes a small but significant error ("Reintroducing the intro course," 31 Aug., p. 1608). Although my friend and colleague Bruce Partridge deserves a lot of credit for convening this meeting, such strategy sessions are not "unprecedented," as Stokstad says.

The Astronomical Society of the Pacific (ASP) has convened four national "Cosmos in the Classroom" symposia on the topic of teaching introductory astronomy (*1*), two of which were cosponsored by the American Astronomical Society, the organization Stokstad mistakenly calls the "American Astrophysical Society."

I mention this small omission in part because one of the issues those scientists and academics who spend time on education are grappling with is that the respect for priority and references is not as well established in education as in research. As a result, articles and papers often report on work that claims to be new but actually duplicates or derives from uncredited earlier work.

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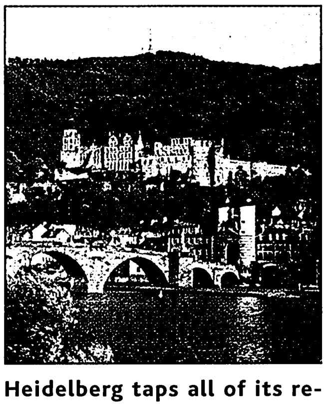
References and Notes
1. Innovative ways to approach "Astronomy 101" can be found in the proceedings of the 2000 conference, which are available through the ASP. More information is available at http://www.astrosociety.org/education/cosmos.html

## Science Education in a University Town

EDUCATION CENTERS AT ALL LEVELS, FROM grammar schools to universities, must address how to prepare students for the rapidly developing world of knowledge, globalization, and technology by not only teaching natural sciences and liberal arts, but also by providing an ethical foundation so that young people learn a sense of responsibility and tolerance.

To achieve these educational goals, young people need to encounter science and research at an early age. A city like Heidelberg offers excellent conditions for this with its university, numerous research centers, and many international institutions, and such conditions can be enhanced by local government policies that promote an exchange between scientists and citizens. The city of Heidelberg, in cooperation with the Heidelberg Economic Development Agency, has developed a program that consists of three major projects: International Summer Science School Heidelberg, Life Science Lab Heidelberg, and ExploHeidelberg.



**Heidelberg taps all of its resources to provide a solid science education for its youth.**

The first project was established in 1996 and is for 18- to 20-year-old pupils who have completed their last year of grammar school in one of Heidelberg's sister cities, that is, Bautzen (Germany), Cambridge (United Kingdom), Kumamoto (Japan), Montpellier (France), Rehovot (Israel), or Simferopol (Ukraine). During the first 3 weeks of this 4-week program, small groups of pupils do practical research work at scientific institutions (such as the European Molecular Biology Laboratory, the Max Planck Institutes for Medical Research and for Nuclear Physics, the German Cancer Research Center, the Biochemical Center of Heidelberg, and several institutes of the University of Heidelberg). The final week is spent by all the pupils in a teaching laboratory at one of the participating institutes.

The second project, Life Science Lab Heidelberg, was established in 2000 at Heidelberg's technology park. It is a joint education program of school, research, and economics that establishes a network among its partners. The Life Science Lab is for pupils from the last 3 years of grammar school (16 to 18 years old). In the first year, 215 pupils applied for 60 available places. The program now allows for 100 pupils who participate in the lectures, weekend courses, and working groups.

The third project, ExploHeidelberg, is still in the planning stages. It will be an interactive exhibition of basic phenomena of natural sciences (the main focus to be on life sciences), including a media and teaching laboratory. Following the example of the Exploratorium in San Francisco, California, ExploHeidelberg will be designed for 6- to 15-year-olds. The opening is scheduled for 2002.

In addition to these three major programs, pupils who have completed grammar school are offered an opportunity to participate in the International Summer Science Institute, a 4-week program at the Weizmann Institute in Rehovot, Israel, that began in 1985 and served as a model for International Summer Science School Heidelberg. In groups of two or three, about 75 students from countries around the world do practical research with scientists from the Institute.

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