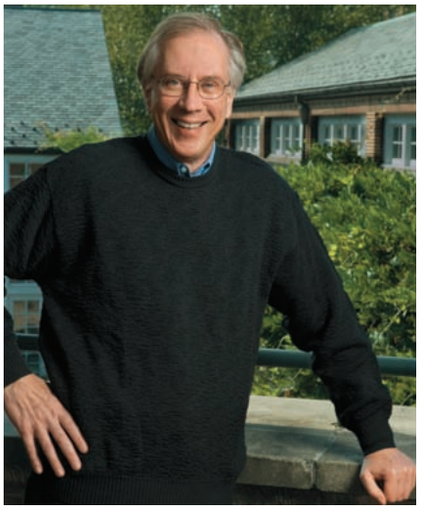
Working Backward to Move Forward



Paul Fetters

FOR MORE THAN 20 YEARS AT THE UNIVERSITY OF COLORADO, I spent many hours in the classroom, sharing a lifelong interest in biochemistry with undergraduate and graduate students. Yet, like many of my colleagues, I may have tackled my teaching assignment from the wrong direction. I went forward when I should have been going backward—at least that's the conclusion I've drawn after reading a handbook on "scientific teaching" written by an HHMI Professor.

As Jo Handelsman and her colleagues at the University of Wisconsin–Madison point out in their handbook, *Scientific Teaching: A Guide to Transforming Undergraduate Biology Education*, the idea is deceptively simple: Decide what you want students to understand and determine how you will assess whether they do, in fact, understand the material *before* deciding how to teach it. In my experience, "backward design"—Grant Wiggins and Jay McTighe coined the memorable description in 1998—is rare. Certainly, I wasn't alone in first choosing a textbook, deciding the order in which to cover the chapters, and seeing when and where I could fit in some demonstrations or experiments to enhance the course—without considering the impact the course would have on the same students a year later.

Since the grants program commenced in 1988, HHMI has invested more than $1.4 billion in a variety of educational programs, among them the HHMI Professors initiative pioneered by Handelsman and 19 other teacher-scholars. Our efforts have ranged from research fellowships for medical students and new graduate training programs to research experiences for undergraduates and outreach programs for K–12 students. HHMI and its grantees now have considerable knowledge of what works and what doesn't, and we're placing a renewed emphasis on extending the reach of our programs.

But because we're scientists, we're also experimenting—experimenting with a variety of approaches to engage the community in high-impact teaching. Right now, we're in the midst of evaluating applications for the second group of HHMI Professors, and I'm struck by the number of accomplished research scientists who have applied. We're committed to the broad dissemination of their experiments in education. In another initiative, HHMI and the journal *Science* have begun a collaboration that will bring information about innovative teaching approaches directly to scientists. In January 2006, the editorial staff at *Science* began producing a monthly section about education. We hope it will engage a broad array of scientists—beyond the life sciences and beyond colleges and universities—with a lively selection of articles intended to pique interest and spark discussion.

The challenge, of course, goes beyond how an individual professor structures a course or even how an individual college or university organizes its science curriculum. In fact, we need to think broadly about how we structure science education, with two goals in mind: generating a cadre of creative scientific thinkers as well as an educated citizenry. When we choose those measurable results, applying the rubric of backward design, it becomes clear that we must rethink the nation's approach to science education.

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> THOMAS CECH

A working paper issued by the National Bureau of Economic Research, which pulled together data from a variety of sources, is illustrative. The demographics of U.S.-trained Ph.D.s in science and engineering have changed substantially over the past 40 years. On the positive side, more women and minorities are pursuing careers in science, but, on the negative, the percentage of U.S. citizens receiving Ph.D.s has dropped significantly. In 1966, 71 percent of Ph.D. graduates in science and engineering were men born in the United States, 6 percent were U.S.-born women, and 23 percent were foreign-born. By 2000, the statistical picture had shifted: 36 percent of all science and engineering Ph.D.s were U.S.-born men, 25 percent were U.S.-born women, and 39 percent were foreign-born.

The recent Summit on National Competitiveness—convened by U.S. Reps. Frank Wolf (R-Virginia), Sherwood L. Boehlert (R-New York), and Vernon J. Ehlers (R-Michigan)—was spurred by an outcry from corporations both large and small about the dearth of well-trained scientists and engineers. The summit has called for nothing less than a transformation of the U.S. educational system. High on the list is a doubling of the number of undergraduate degrees in science and mathematics to 400,000 a year by 2015. It's a tall order, particularly in an era when many technical jobs are being exported overseas and federal research funding is being reduced. By defining the goal—and working backward—the nation may, with contributions from organizations like HHMI, move forward.

Thomas R Cech