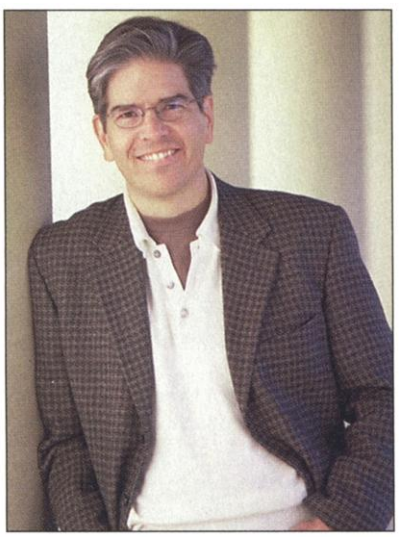
UNDERGRADUATE EDUCATION

Can Universities Be Bribed To Train More Scientists?

Economist Paul Romer has persuaded Congress to test his theory of why too few U.S. students major in science and engineering. But is money the real roadblock?

Stanford University economist Paul Romer readily accepts the conventional wisdom that the United States isn't producing enough scientists and engineers to ensure a healthy economy. But his explanation of who's to blame, and how to fix the problem, is anything but conventional.

Romer argues that U.S. universities deliberately underproduce science and engineering graduates because they are so expensive to train. The traditional weeding-out process is simply a smokescreen for holding down costs, he says. His solution: Pay the universities to turn out more scientists and engineers. "Most schools will do the right thing if you make it worth their while," asserts Romer, who has spent 15 years analyzing the factors behind long-term economic growth.



Filling the pipeline. Paul Romer says degrees will follow the dollars.

His fresh insights into what has traditionally been seen as an intractable problem have made Romer the darling of politicians and business leaders who believe that the federal government should be playing a bigger role in training the next generation of scientific talent. His ideas have formed the basis for new legislation, the Technology Talent Bill (S. 1549 and H.R. 3130), that would create a competitive grants program at the National Science Foundation (NSF) for universities that promise to boost the number of undergraduates majoring in science, mathematics, and engineering. The concept is so appealing politically that last month Congress gave NSF $5 million to start a pilot project to test Romer's thesis even before it took up the authorizing legislation (*Science*, 16 November, p. 1430).

Most educators agree that the country needs more scientists—and are delighted that Congress is willing to tackle the problem. But the vast majority take strong exception to Romer's analysis. They say it ignores a vast body of literature on why students avoid or drop out of the sciences, from the field's unappealing image to high family expectations, that have nothing to do with an institution's unwillingness to pay the bill. Romer's explanation fails to account for the steady growth in the life sciences, they note, as well as the realities of higher education, where departments compete for students and universities flaunt their scientific prowess.

"That's nuts," says William Saam, chair of the physics department at Ohio State University, Columbus, when asked about Romer's argument. "Of course we could do better with more resources. But we are working hard to increase the number of majors, and so is every other physics department in the country."

The power of an idea

A self-proclaimed naïf in the corridors of political power, the 46-year-old Romer has a pedigree that opens doors. He's the son of Roy Romer, a former governor of Colorado and head of the Democratic National Committee who's now superintendent of Los Angeles schools. He's also been touted in the media as a potential Nobel Prize–winner for his pioneering work on endogenous growth theory: the idea that economic growth is driven by new technology.

Technology, in turn, depends on a steady flow of scientific talent. But Romer argues that U.S. colleges and universities winnow out a large percentage of students who express interest in science and engineering through tough grading and a survivalist mentality in introductory courses. Faculty and administrators then cite the need for high academic standards as a rationale for their behavior, which Romer says is deeply rooted in the culture of science. The emphasis on research over teaching at many top schools reinforces such behavior, he argues.

But money can change such attitudes, he says, provided departments are rewarded for churning out more science graduates. As proof, he cites a 3-year-old Canadian program that pays Ontario universities up to $5000 for each new computer science and engineering student. So far, undergraduate enrollment at the 17 eligible universities has jumped by 145% in engineering and by 180% in computer science.

One of Romer's earliest and most important political converts was Senator Joe Lieberman (D–CT), the driving force behind the Technology Talent Bill and a staunch advocate of doubling the NSF budget and increasing federal support for training the next generation of scientists. "We've been wrestling with this issue for a long time," says one Lieberman staffer. "So the idea of rewarding the gatekeepers if they can produce more majors was very appealing." Romer's message also warms the hearts of high-tech business leaders, who complain that they must import tens of thousands of foreign-born workers because the U.S. talent pool is too shallow. As a result, Romer has broken bread with groups ranging from the New Democrat Network and the Washington, D.C.–based Council on Competitiveness, a coalition of CEOs that lobbies for increased government spending on research and training.

Romer's initial proposal for priming the technology pump, outlined in a June 2000 working paper (www.nber.org/papers/w7723), would have offered training grants to undergraduate science departments and portable fellowships for graduate students as well as tax breaks for industry. However, its multibillion-dollar-a-year price tag scared off more than a few supporters. As a result, the Technology Talent Bill calls for a $25 million a year pilot program for undergraduates, and it gives NSF plenty of leeway to set the rules of the competition. Staffers say Lieberman and others envision it growing to $200 million annually if it proves successful.

Theory vs. reality

Romer's argument, and the legislation that is based on it, rests on two key assumptions: There is a large reservoir of qualified students interested in majoring in the natural sciences and engineering, and U.S. universities have excess capacity to handle such an influx. But many educators question whether either premise is true.

Romer and his supporters cite the traditionally high attrition rate in the sciences as proof that many students are being pushed out of fields they want to pursue. A 1992 study by Alexander and Helen Astin of the Higher Education Research Institute (HERI)

at the University of California, Los Angeles, for example, found persistence rates of only 40% to 50% for first-year students declaring an interest in the natural sciences and engineering. But such shifts in interest are not unusual for first- and second-year students, say educators, and the percentages have held steady over the years, according to data from HERI, which has surveyed incoming freshmen for 35 years.

Many educators join with Romer in decrying what Michael Teitelbaum of the Alfred P. Sloan Foundation in New York City calls the "boot camp" mentality in many top-tier science departments. But Romer stands alone in attributing it to economic causes. "That's a weird one," says Roman Czujko of the American Institute of Physics in College Park, Maryland, which closely tracks science enrollment and graduation trends. "Departments have to justify their size to the dean," he says, "and the best way to do that is with more majors. Besides, university presidents recognize that having a vibrant science program is essential for attracting top students in all fields."

Retention and attrition in higher education are affected by many factors, say other scholars. Elaine Seymour, a sociologist at the University of Colorado, Boulder, and co-author of a 1997 book on why undergraduates drop out of science, cites "appalling teaching" as a much bigger reason for driving students away. The solution, she says, requires systemic reform of the science curriculum at all levels and improved teacher training.

Romer's assumption that there's unused capacity for educating more scientists and engineers gets equally short shrift. "I can't turn out any more B.S. students in engineering without a major investment in space and faculty," says Janie Fouke, dean of engineering at Michigan State University in East Lansing. "And my colleagues are in the same boat. We all want to produce more graduates, in particular women and people of color. But the scale of an award that would accomplish that, in terms of size and duration, is probably much bigger than anything that is likely to be offered."

Canadian educators say it's not clear whether the Ontario program is relevant to the U.S. context. The additional money, by itself, wouldn't have been enough to justify expansion, says Sujeet Chaudhuri, dean of engineering at the University of Waterloo, the province's top technology institution, which declined to participate the first year because the government's doubling target was too high, he says. Instead, it was the new authority to charge higher tuition—10% to 15% more a year for the next 3 years—that made it economically feasible for the department to expand. Demand has held steady, says Chaudhuri, but that might not be the case in a more competitive U.S. market. In addition, U.S. administrators say that political realities would make it impossible for their universities to levy tuition hikes of that magnitude.

Romer says his economic solution allows plenty of room for fine-tuning. "I say that people will respond to incentives, but I can't tell you what the exact number should be," he says. "And I'm not trying to sell this as a solution to the problem of underrepresentation in science, although I think that whatever you do to eliminate weed-out mode will disproportionately benefit those groups."

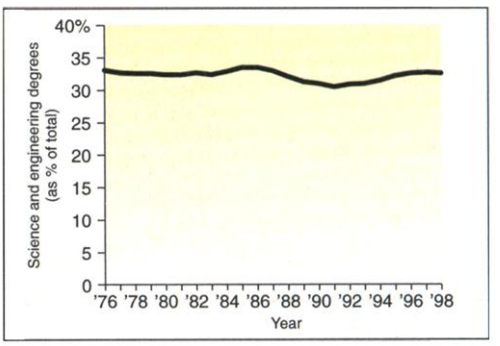
For most academics, however, what he is selling is too facile. "It's typical of an economist to pick out one thing," scoffs Colorado's Seymour. "It won't hurt, but it won't fix the problem."

—JEFFREY MERVIS

Undergraduate Data Show a Shift, Not a Decline, in Interest

Amid all the hand-wringing about the declining interest in science among U.S. students, one significant fact has been largely ignored: Undergraduates today are just as likely to earn bachelor's degrees in the sciences as they were when Jimmy Carter was president.

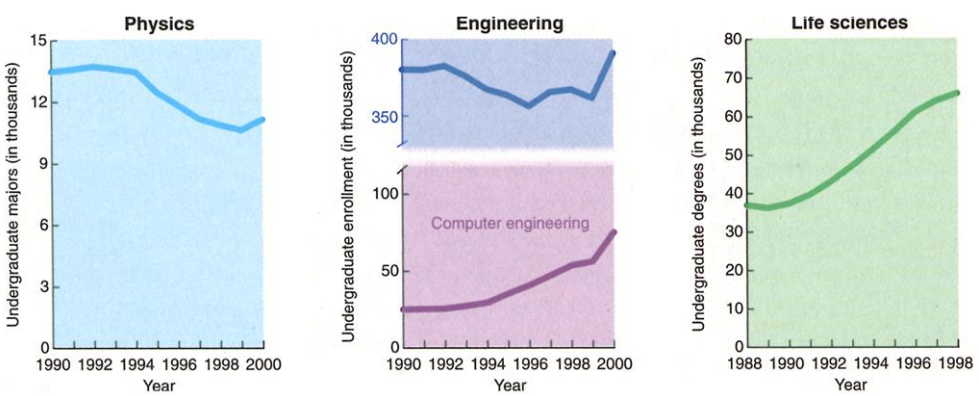
To be sure, there have been shifts within the natural sciences and engineering, as interest in particular fields have waxed and waned. Policy-makers have been quick to cite such worrisome numbers as a 37% drop in the number of computer science degrees awarded since 1984 and a 25% drop in physics majors since 1988. But declining interest in those relatively small fields has been more than offset by a spectacular rise in the life sciences, up 83% in the past decade after a dip during the 1980s. At the same time, computer engineering has been hot throughout the decade, topped by a 35% jump last year that brings the 2000 enrollment to triple the 1990 level. And women have a greater presence in almost every scientific discipline. Overall, data from the National Science Foundation (NSF) show that the fraction of U.S. undergraduates choosing to major in science and engineering has stayed remarkably constant—roughly one in three—for more than a generation.



Staying power. Students don't seem to have lost interest in science.

The numbers suggest that any program that relies on financial rewards to pump out more science majors may be ignoring the natural ebb and flow of students from one technical field to another based on perceived opportunities. At the same time, the overall stability of the scientific talent pool is no cause for complacency. "For 35 years the number of [science, mathematics, engineering, and technology] graduates has oscillated around one-third of the total B.A. pool," agrees Norman Fortenberry, head of NSF's undergraduate programs. "But today's world requires a greater level of technological sophistication. So it's more important than ever that we find ways to reach that other two-thirds."

—J.D.M.



Numbers game. The last decade has seen big shifts in enrollment by discipline.

SOURCES: (TOP) NSF/SRS; (BOTTOM, LEFT TO RIGHT) AIP STATISTICAL RESEARCH CENTER; CPST; U.S. DEPARTMENT OF EDUCATION, NCES