College Science: Pass, No Credit

Now is a good time to look at undergraduate education in the sciences, for two reasons. It matters: society needs to prepare an adequate number of talented young people to do science and to do it well. At the same time, public policies increasingly hinge on scientific and technical issues. How well those decisions are made will depend on whether policy-makers and voters have gained, in their higher education, an adequate literacy in science. On both counts, undergraduate science education gets a pass but doesn't earn credit.

A diagnosis of how we are faring would yield a mixed report for the industrial world. For example, only a small proportion of students in the United States, having entered college less well prepared than European and Asian youth, decides to major in science. The national average hovers around 8% of all enrollees. But the fine structure is interesting. In the selective undergraduate liberal arts colleges, it may be as high as 20 to 25%—larger and faster growing than in comparable research universities. The former also go on to earn doctorates at a much higher rate. For the decade 1986 through 1995, the proportional Ph.D. productivity of undergraduate institutions was far higher than that of the research universities; the top five included four liberal arts colleges. The top two, Reed and Swarthmore, nearly doubled the proportional productivity of Harvard and Yale.

What explains this geography? Is it that the intimacy and small class sizes characteristic of the liberal arts colleges are especially good at luring future scientists? Or could it be that something about the higher-pressure lives led by faculty and graduate students in the major research universities discourages the undergraduates who observe and are taught by them? If we are seriously interested in attracting the best and the brightest into the sciences, we need to find out. And if we care about science literacy, the problem may be that we give the nonscience majors barely a fleeting touch of science, even in the best places. A Harvard senior can graduate with only one-sixteenth of his or her course work in the sciences. The phrase "liberal education" still means "some humanities for the scientists and engineers"; it seldom is taken to suggest "some science for the English majors."

Yet there are encouraging signs to report. Compared to what went on one or two decades ago, today's courses are more far more exciting and engaging. Experiments in service learning, imaginative uses of information technology, and greater emphasis on inquiry and independent study have done wonders for the quality of the undergraduate science experience. Much of that is due to the inspiring commitment of individual faculty members to teaching experiments such as the examples described in this issue. Here in the United States, a long-term interest at the American Association for the Advancement of Science and foundation partners has generated projects to improve the yield of minority students from undergraduate science programs. And under President Bruce Alberts, the National Academy of Sciences has become a positive force in developing new modes of science teaching. Reform is in the air, but much of the reform has been directed at the typical 18-to-22-year-old undergraduate.

That target is moving, as student bodies are changing in most industrial nations. There are more women, more ethnic diversity, and more "nontraditional" students: those who are older, working part time, or attending different kinds of institutions, such as the Open University in the United Kingdom. Whatever the venue or the audience, the Internet will surely change what is possible. But the highly touted prospects for "distance learning" look, at least to this observer, oversold. We already have distance learning in most university science courses; it's called the lecture. The great hope for the Internet is to enhance faculty-student communication and enable more individualized guidance and feedback in problem-solving—in short, to become an instrument for proximity learning.

Governments everywhere have a huge stake in their national scientific capacity and thus in science education. In the United States, we have looked to the National Science Foundation's (NSF's) education programs as a source of innovation and encouragement. Although NSF has fared poorly in the administration's 2002 budget proposal, Congress appears likely this fall to increase that request in both the research and education accounts, including some programs that serve undergraduates. The need is obvious, and not just in the United States. Meeting the scientific challenges facing our world will require a global population of well-educated citizens.

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