The Condition of Undergraduate Science Education: The NSF Perspective

The results of seven recent discipline-oriented workshops sponsored by the National Science Foundation on science education problems express a number of common, independently formulated themes.[1] Individual workshops, each attended by about 20 scientists drawn from a wide spectrum of institutions in the research and education communities, focused on the disciplines of Biology, Chemistry, Computer Science, Engineering, Geoscience, Mathematics, and Physics (which included Astronomy and Materials Science). They all described a concern for the current condition of undergraduate science education in this country; they all stressed a need for NSF action; and they all produced detailed recommendations for NSF action in their respective disciplines.

The report of the Physics workshop describes the poor condition of undergraduate science education in terms of three basic underlying problems. (1) Teaching is considered to be a second-class activity compared to research; (2) science has become isolated from the broad body of knowledge expected of the well-educated person; and (3) insufficient interchange exists between the research and teaching communities. All this, according to the Chemistry workshop participants, has led to a situation where "undergraduate education in science and engineering in the United States is in a state of crisis." The participants of the Geoscience workshop stated that "inadequate precollege instruction, declining enrollments, deteriorating instructional facilities, and lack of funding for research efforts involving students are particularly evident." The workshop reports also strongly suggest that the deteriorating condition of precollege education is a major factor contributing to the current status of undergraduate science education. In effect, more resources are having to be expended at the post-secondary level on remediation, which in turn detracts from efforts to provide students up-to-date material at the college level.

Workshop participants felt, in general, that the nature of the solutions to the perceived problems requires a national response, even though the details would be expressed locally. The Engineering workshop participants observed that the NSF's response thus far has been "insufficient to even stem the tide let alone to begin to resolve the issue". From the collective point of view of all the workshops, the NSF was urged to expand or initiate programs in a number of major areas, including laboratory instruction, course and curriculum development, faculty and student concerns, and the attraction and retention of under-represented groups.

All workshop reports agreed that the laboratory is the most critical element of instruction in the science and engineering disciplines. Even the Mathematics workshop report placed emphasis on the needs of that discipline to incorporate a laboratory component and to bring technology into its instructional process.

In all workshops, laboratory was stressed as important because it is the vehicle by which students get a true insight into the scientific process. In most disciplines, the introductory laboratory experience was believed to be more instrumental in diverting students from—rather than attracting them to—the discipline. The workshops called for broad-based support of laboratory development and improvement at all types of institutions, i.e., two- and four-year colleges and research universities. Issues relating to the role of the laboratory in the curricula need to be examined critically; experiments and activities must be designed and developed that challenge and excite students.

The curriculum, in its broadest sense, was viewed by all disciplines involved as needing serious attention, especially in the lower-division courses. It was suggested that efforts should be encouraged in all disciplines to both analyze and restructure courses and curricula. It was further suggested that the NSF should assist the leadership within the disciplines to examine and implement activities that address the perceived curricular needs.

The faculty was identified as the key to the solution of the problems that must be addressed in order to produce a more positive undergraduate experience in the sciences. Two kinds of faculty-oriented efforts were identified in the reports: those intended to attract and motivate research-oriented faculty to work on improving teaching, and those aimed at helping teaching faculty achieve and maintain technical competence.

The under-represented group—women, minorities, and the disabled—were recognized as an important factor in alleviating the shortfall of scientists and engineers predicted by demographics. A variety of programs were recommended to identify and nurture members of these groups. Especially important in the opinion of the workshop participants are precollege programs that will identify under-represented students at the precollege level with the potential to excel in the sciences.

As part of its response, the NSF has announced an expanded program to support major efforts to reshape and strengthen undergraduate courses, curricula, and attendant laboratories in engineering, mathematics, and the sciences. Now is the time for the chemistry community to become critical and to think innovatively about the teaching of chemistry to undergraduates. The opportunity is ours to seize!

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[1] Copies of *Report on the National Science Foundation Disciplinary Workshops on Undergraduate Education* can be obtained by calling (202)357-7051 or by writing the NSF Directorate for Science and Engineering Education, Washington, DC 20550.