

This summary has been prepared because the work in these documents

- Serves to underscore the role of science and mathematics education in the issues concerning OPAS.
- Argues for addressing the educational needs of the majority of students not just those who will major in SMET fields.
- Articulates the linkage among precollege, college, and graduate education in meeting educational goals.

NSF 96-139 -- SHAPING THE FUTURE: *New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology*

October 03, 1996

NSF 98 -128 - SHAPING THE FUTURE Volume II: *Perspectives on Undergraduate Education in Science, Mathematics, Engineering, and Technology*

Contributions to the Review of Undergraduate Education by the Advisory Committee to the National Science Foundation Directorate for Education and Human Resources  
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### ***The Problem***

Too many students leave SME&T courses because they find them dull and unwelcoming. Too many new teachers enter school systems underprepared, without really understanding what science and mathematics are, and lacking the excitement of discovery and the confidence and ability to help children engage SME&T knowledge. Too many graduates go out into the workforce ill-prepared to solve real problems in a cooperative way, lacking the skills and motivation to continue learning.

### ***The Goal***

All students have access to supportive, excellent undergraduate education in science, mathematics, engineering, and technology, and all students learn these subjects by direct experience with the methods and processes of inquiry.

### ***Summary***

1. America's undergraduates - all of them - must attain a higher level of competence in science, mathematics, engineering, and technology.
2. America's institutions of higher education must expect all students to learn more SME&T, must no longer see study in these fields solely as narrow preparation for one specialized career, but must accept them as important to every student.
3. America's SME&T faculty must actively engage those students preparing to become K-12 teachers; technicians; professional scientists, mathematicians, or engineers; business or public leaders; and other types of "knowledge workers" and knowledgeable citizens.
4. It is important to assist them to learn not only science facts but, just as important, the methods and processes of research, what scientists and engineers do, how to

- make informed judgments about technical matters, and how to communicate and work in teams to solve complex problems.
5. America's businesses and industry, governments, and foundations must provide active assistance and support in this critical endeavor.
  6. In an increasingly technical and competitive world with information as its common currency, a society without a properly educated citizenry will be at great risk and its people denied the opportunity for a fulfilling life.

### ***Opting Out of Technical Subjects***

The extensive study *Talking About Leaving* [8] by Elaine Seymour and Nancy Hewitt notes the high attrition rates among SME&T majors -for reasons having little to do with two popularly misconceived causes, namely language problems with foreign Teaching Assistants and large class sizes. Rather, the major reasons students identify for dropping out of SME&T have to do with the intimidating climate of the classroom, the poor quality of the educational experience (including too much dull lecturing and poor academic advising), the lack of encouragement for those interested in becoming K-12 teachers, the lack of motivation, inadequate counseling about career opportunities, and general lack of nurture of the student. SME&T education at the undergraduate level today is largely passive rather than active. It is certainly not providing "all students" access to "supportive, excellent" SME&T experiences that acquaint them with "the methods and processes of science."

### ***Preparation Teachers***

At a hearing conducted as part of this review [10], the superintendent of a major urban school system commented about new teachers coming out of undergraduate programs: "Many new teachers arrive at their first assignments lacking sophisticated skills in writing, speaking, and computing. All new teachers should be able to use technology and adapt to its roles and applications. SME&T content is also essential for all new teachers. In their content areas, SME&T teachers should know more about the subject materials than they are required to teach . . . (and they) should have the benefit of sufficient practicum/internship experience before they graduate."

### ***Participation by Minorities***

SME&T and SME&T education have historically been the domain primarily of white males. Questions of value and equity aside - and they are not aside - the facts that the majority of Americans are women and that the proportion of Americans aged 18-22 who are members of racial or ethnic minority groups will rise in the aggregate from 25% in 1980 to more than 35% by the turn of the century (and that number is expected to rise above 40% by the year 2015) have profound implications for SME&T education. Unless SME&T education is much more inclusive than it has been in the past, we will be denying ourselves as a society the talents of the majority of our population. This is an intolerable situation - it is both morally wrong and economically foolish.

***Barriers to Improvement***

1. Widely varying levels of student ability, and poor preparation for SME&T studies by many.
2. Curricular and pedagogical problems, including a lack of interdisciplinary courses.
3. Ineffective use of instructional technology.
4. A faculty reward system that does not emphasize the importance of instructional effectiveness.
5. The related problem of inadequate use of evaluation for making informed choices about new curricula and teaching methods.
6. Lack of resources for faculty development, for efforts to disseminate improved practices, and to provide modern instructional equipment and materials to their students.
7. Organizational issues: poor institutional articulation among institutions (high schools and colleges; two-year and four-year colleges; colleges and employers and states) and within institutions (linking teaching and research roles, linking SME&T departments, especially the education and science faculty); resistance to change by key people within academe; indifference to the need for comprehensive change.

**References**

Elaine Seymour and Nancy Hewitt, *Talking About Leaving: Factors Contributing to High Attrition Rates Among Science, Mathematics, and Engineering Undergraduate Majors* (Boulder, CO: Bureau of Sociological Research, University of Colorado, 1994).