Mathematics for the Technical Work Force

COMMENTARY

By Susan Forman and Lynn Arthur Steen

Conventional wisdom about mathematics education has often focused on "three Ts": texts, tests, and teachers. Current political priorities have added two more Ts: tracking and technical education. The last two elements, although somewhat less visible, especially to mathematicians, are no less important for the quality of mathematics education.

The campaign for advanced technical education is a centerpiece of the Clinton administration's education program. The economic rationale for this priority is clearly spelled out in Robert Reich's *The Work of Nations*. The political rationale is centered in the need for an internationally competitive workforce. The personal rationale can be seen in the long lists of college graduates (and PhD recipients) who cannot find work suited to their education.

To improve the transition from school to work, Labor Secretary Reich and Education Secretary Richard Riley advocate greater emphasis on programs in grades 10–14 that prepare students for technical careers in fields such as telecommunications, manufacturing, and agriculture. Just as educators have developed standards for mathematics and other subjects, so now industry associations are developing occupational standards in "skills clusters" to provide a portable national credential that will fit the workplace better than the traditional high school or college diploma does.

At the school level, many of these occupational training programs fall under the general title of "tech-prep"; at the college level—most often at two-year colleges—the moniker of a new National Science Foundation program, Advanced Technical Education (ATE), provides a convenient descriptor. Many of these programs combine the last two years of high school with the first two years of postsecondary education into "2 + 2" programs.

In a recent study entitled "Preparing for the Workplace," the National Research Council reports that only one in five adults has a four-year college degree. The other 80% enter the world of work either directly from high school or after completing some nonbaccalaureate form of postsecondary education in institutions ranging from community colleges to proprietary vocational institutes, and in programs sponsored by employers or communities. Overall, 50% of recent high school graduates obtain postsecondary education in contexts that do not lead to a four-year bachelor's degree.

No matter what the institution or the program, mathematics plays a critical role in all such technical education: Virtually every course of study requires mathematical preparation, often quite different from the traditional "school-to-college" preparation that leads from algebra to calculus. That is where the other "T" comes in: The growth of school-to-work programs, valuable as they may be to many students, may well lead to a new and potentially invidious form of tracking.

The historical form of tracking that the National Council of Teachers of Mathematics argued against in its *Curriculum and Evaluation Standards for School Mathematics* (1989) relegated large numbers of students, a disproportionately large number of them minorities, to dead-end courses in which the students received little challenge and even less education. The new career-based tracking will be more seductive (who can resist the allure of high-tech occupational preparation?) but equally capable of perpetuating socioeconomic class distinctions. Decisions made in early high school years—especially decisions about mathematics courses—can program students into a tech-prep or college-prep curriculum with little opportunity for switching. Yet the disposition to change that is seen in students between the ages of 15 and 20 virtually guarantees that no inflexible system of early tracking can be personally or educationally sound.

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ATE programs employ distinctive examples in which mathematics is often embedded in occupational contexts rather than presented within a traditional disciplinary framework. That such programs differ from the traditional precollege track does not necessarily make them worse, weaker, or watered down. But the presence of two parallel and quite different tracks, possibly beginning in grades 9 and 10, may prematurely foreclose future options at a time when neither students, nor parents, nor teachers can reliably predict a student's educational trajectory.

This poses a special challenge to the mathematical community: how to support the clear national need for tech-prep and ATE programs without undermining the students' option to choose a traditional four-year bachelor's degree program. Educators also should be concerned that some students who are on the fast track for traditional college programs—sometimes under parental or peer pressure that may not reflect their

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true interests or abilities—may finish high school ignorant of options for post-secondary technical or vocational preparation that may suit them better than traditional college programs.

One resolution of this dilemma would be a common mathematics program that could serve equally well as preparation for college and as preparation for skilled work. All students could benefit from the broadening effects of such a high school preparation, yet there are currently few good models of curricula that serve both masters. The challenge of a common program opens up questions on many fronts:

- What would it take to convince high school and college teachers that there is a common good in such a curriculum?
- How can mathematicians contribute their understanding about the practice of mathematics to the tech-prep and ATE movements and obtain insights from these movements that may benefit their teaching and research?
- Is it possible to develop performance expectations for high school mathematics that successfully reflect the goals of both the school-to-work movement and the school-to-college tradition?
- At what grade level should a common curriculum give way to tracks that lead in distinctly different directions?

Mathematicians who think about curricular issues typically focus primarily on the academic track that leads to scientific, engineering, and mathematics courses at the university level. Those who develop curricula for the technical and vocational programs rarely work with mathematicians or mathematics educators to ensure consistency with the expectations and standards of mathematics education. Despite the current schism between these two communities, the increasing political pressure for educational alternatives such as tech-prep and ATE provides mathematicians with a marvelous opportunity to demonstrate the universal applicability of their discipline—to show that it is good for something other than preparing more university professors.

It is far too early to say with assurance how the many challenges of school-to-work programs will play out in the real world of education and politics. We can be certain, however, that they will occupy an increasing share of attention and resources, perhaps even becoming the dominant curriculum in the schools. Mathematicians have much to contribute to this discussion; we ignore it at our peril. Now is the time to get involved, to learn what the issues really are, and to use the many resources of our discipline to work with other constituencies to frame an effective response to this clear national need.

The Mathematical Sciences Education Board (MSEB) will sponsor a panel, Mathematics for the Technical Work Force, on Thursday, July 28, at the 1994 SIAM Annual Meeting in San Diego. Gil Strang, SIAM vice president for education, will moderate the panel; panelists will include Jack Price, president of the National Council of Teachers of Mathematics, and the authors of this article.

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