S. Tobias
724 N.Campbell Avenue, Tucson, AZ 85719, U.S.A.

Who will study math and for what purpose?

The reasons for studying mathematics over the centuries have ranged from its raw utility to disinterested curiosity. For Plato and the educators who followed, mathematics is the consummate discipline for training the mind; for Pythagoras and those who followed him, a mystical, indeed, an almost spiritual endeavor.

In an ever more technical economy, however, the study of mathematics at university is no longer (if it ever was) appropriate only for those who will contribute new knowledge to the field. It has become the foundation for a whole range of professional options from 'computational science' to management. But university professors of mathematics (with some exceptions) continue to view their students from a more narrow perspective: either as future research mathematicians or as not worth encouraging if they do not have the interest, the 'talent,' or the temperament for research.

Faced with declining enrollments in university mathematics in the 1970s, math educators in the U.S. and Britain began to critically examine the curriculum, the pedagogy, the 'nerd' image, and (eventually) the competitive 'classroom culture' in university mathematics in an effort to attract a wider range of students to the study of mathematics.

The terms 'math anxiety' and 'math avoidance' were coined in that period to account for negative attitudes toward mathematics by otherwise able and ambitious university students. My books, *Overcoming Math Anxiety* (1978, and revised, 1995), *Succeed with Math* (1987), and *They're Not Dumb, They're Different* (1990) were all part of that campaign.

Today, in the U.S., the campaign is entering a second phase. No one doubts that university graduates with highly developed quantitative skills are going to be in demand in every sector of the economy, and not just in research. The financial, health-care, bio-tech, environmental, and consulting communities have already discovered the value of mathematics (and/or physics) trained professionals who are capable of employing quantitative methods to define and manage risk. ('Physicists Graduate from Wall. St.', *The Industrial Physicist*, Dec. 1999). Ever-more sophisticated applications for computers require mathematics trained professionals as well.

In response to these developments, a number of U.S. universities are trying to aggressively reclaim the mathematically able student who is not bound for a research career by providing post-baccalaureate degree options that build on mathematics in new ways. SIAM (The Society for Industrial and Applied Mathematics) is formally encouraging the establishment of *new* master's degrees in applied, industrial, and financial mathematics. These programs, which require two additional years of study after the bachelor's (including an internship) are intended to provide *professional* in contrast to *academic* training, and to launch students into a wide variety of interesting, intellectually challenging, and well-paid careers.

There are at present between thirty and forty new professional master's programs in mathematics, many of them in leading U.S. universities, such as NYU, Chicago, Columbia, Carnegie Mellon, and Georgia Institute of Technology. In addition, the Alfred P. Sloan Foundation of New York has announced a grants initiative for new professional M.S. degree programs in computational molecular biology (bioinformatics) for which mathematics B.S. graduates willing to learn to apply their mathematics training to problems in molecular genetics are being recruited. Other professional M.S. programs in mathematics-based emerging fields (such as computational chemistry), are just now being launched. (For a list of science or mathematics based new professional M.S. degree programs in the U.S., see www.ScienceMasters.com)

The hope in the U.S. is that by supplying the non-academic workplace with mathematics professionals, three goals will be accomplished: 1) an increase in the number of students willing to enroll in mathematics; 2) an increase in appreciation for mathematics training among managers and policy-makers; and 3) an increase in funding for mathematics research. But first, academic mathematicians have to be persuaded to incorporate real-world problems in their teaching, and to encourage non-academically oriented students to pursue the mathematics degree.

In The Netherlands, the solution to the problems of underenrollment and undervaluing of mathematics training will inevitably take different forms. The doctoraal degree represents a higher level of attainment than the U.S. bachelor's, and the Anglo-American master's degree hardly exists. The possibility of a *minor* in mathematics at the University of Amsterdam, and the development of a customized beta-management program at Leiden University offer some new possibilities for students. But the implementation of these new programs (as has been the case in the U.S.) will involve a radical shift in the *values* and the *culture* within the mathematics community. Whether the professoriat is ready for that shift may determine *who* studies mathematics and for what *purpose*. Students, inevitably, have their eyes on the future. All too often their professors are nostalgic for the past.

Sheila Tobias is a U.S. based author and educator. She is 'Outreach and Diffusion Coordinator' for the Alfred P. Sloan Foundation's new professional M.S. degree program initiative.