Reports Assess U.S. Standing in Mathematics

Within the past year, two major reports have been issued that attempt to assess the international standing of U.S. mathematical sciences research. The reports are part of an effort by the federal government to plan more coherently and more strategically its support of scientific research.

The first report, "International Benchmarking of U.S. Mathematics Research", was issued in October 1997 by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences (NAS). It comes in response to the 1993 COSEPUP report, "Science, Technology, and the Federal Government: National Goals for a New Era", which outlined a methodology for making decisions about federal spending on research. The first step in the methodology is to assess where the U.S. stands in comparison to its international peers in various scientific areas. Mathematics was the first field for which such a comparison was done; an NAS benchmarking report of materials science was released in April.

The second mathematics report, issued by the National Science Foundation (NSF), is called "Report of the Senior Assessment Panel of the International Assessment of the U.S. Mathematical Sciences". The NSF purposely chose as panelists individuals who had not recently received funding from the Foundation. Issued in March 1998, the report was produced in compliance with the Government Performance and Results Act (GPRA), which requires federal agencies to set strategic goals and evaluate their progress toward those goals. The NSF's goals call for upholding the U.S. position of world leadership in research, promoting the use of science in service to society, and achieving excellence in education.

While the two reports have many similarities, they are strikingly different in tone and outlook. In fact, the NSF report does not even mention the NAS report even though the latter had been out for six months by the time the NSF report was completed. Bland and dry, as most Academy publications are, the NAS report may have suffered from the fact that the panel producing it was instructed not to make any recommendations. The NSF panel, by contrast, was charged with making specific recommendations to the Foundation. Consequently, the NSF report is more opinionated and forceful, as well as longer and more detailed.

Both reports conclude that the U.S. is the world leader in mathematical sciences research. Among the evidence offered for this conclusion is the fact that U.S.-based mathematicians write about 40 percent of all research articles in the subject and claim a healthy share of international honors, such as prizes and invitations to speak at major meetings like the International Congress of Mathematicians. Despite these signs of success, the NSF report says that mathematicians in the U.S. suffer from a sense of "low morale" not found among their counterparts in Western Europe and the Pacific Rim. When it comes to promoting the use of mathematics outside the field, the U.S. is not doing much better than its peers: The NSF report states bluntly, "Communication between mathematical scientists and other scientists is poor the world over." In mathematics education, the reports say that the U.S. is clearly the leader at the Ph.D. level, attracting talented students from all over the world.

Both reports say that mathematics in the U.S. is strong, but warn that this strength is “fragile”.

One of the reasons given for this fragility is the decline in federal support for mathematics; ironically, the NAS report counts good federal support in the past as one of the factors that has made mathematics in the U.S. so strong. One of the main themes of the NSF report is that federal support for graduate students and young researchers in mathematics is far below that for their counterparts in the physical and biological sciences. The emphasis on federal support is secondary in the NAS report, which says that the predominant factor contributing to the strength of U.S. mathematics has been the support of private and public universities. In fact, in its closing sentences the NAS report states: “The most important safeguard of U.S. preeminence in mathematical research—and in all the sciences—is the flourishing of both private and state research universities.”

The NSF report suggests that the low level of federal support for young people in mathematics has induced talented undergraduates to enter other fields, leading to an overall decline in recent years in enrollments in U.S. Ph.D. programs in mathematics. The NAS report presents data showing that U.S. mathematics Ph.D.s have lower median salaries than those in other sciences and engineering. Also contributing to the lack of appeal of mathematics is the anemic academic job market, coupled with the perception that a career in academia is the only path open to a mathematics Ph.D. According to the NSF report, this is a misperception: “With a reorientation of curriculum and of employment expectations, possibilities for a career outside academia are very bright for mathematically talented and well-trained individuals.”

The NSF report hammers away at the notion that mathematics must be open to taking on mathematical problems that arise in other fields of science, in industry, and in society. Academic mathematicians come in for some criticism for being “insufficiently connected” to users of mathematics, though the division of universities into departments, the rigidity of funding agencies, and lack of support from industry also take some of the blame. In its recommendations the report states that the NSF’s objective should be to build an academic mathematical sciences community “that is both intellectually distinguished and relevant to society,” noting that the inclusion of societal relevance is an “important shift in emphasis” for the Foundation. More specifically, the report recommends that the NSF “promote interactions between university-based mathematical scientists and users of mathematics in industry, government, and universities.” The report makes it clear that the NSF has the clout to influence mathematics in the directions recommended. After presenting a graph that shows that the NSF holds the purse strings on

Report of the Senior Assessment Panel of the International Assessment of the U.S. Mathematical Sciences, National Science Foundation, March 1998.

Available on the World Wide Web at: `http://www.nsf.gov/cgi-bin/getpub?nsf9895/` and `http://www.nsf.gov/pubs/1998/nsf9895/nsf9895.htm`.

Available upon request from: Division of Mathematical Sciences, National Science Foundation, Room 1025, 4201 Wilson Boulevard, Arlington, VA 22230; telephone 703-306-1870.

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International Benchmarking of U.S. Mathematical Research, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, 1997.

Available on the World Wide Web at: `http://www2.nas.edu/cosepup/`.

Order from: National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 1-800-624-6242 or 202-224-3313 (in the Washington metropolitan area).

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about 60 percent of all federal funds for mathematics research (with the remainder scattered among six other agencies with varying missions), the report notes that the Foundation has "high leverage in enforcing change."

Some of the most intriguing material in the NSF report appears in the appendices. One is a piece called "Possible Trends in the Coming Decades", by Mikhael Gromov; it is reproduced in the "Forum" column of this issue of the *Notices*. Another appendix contains an assessment of U.S. standing in various subfields of mathematics. For example, the assessment of algebraic geometry and number theory states that leadership in algebraic geometry is shared by the U.S., Japan, and Western Europe, "with the United States having the most active researchers." It comments that in the U.S., computational algebraic geometry "lacks depth, and leadership is held by the Europeans." It also notes that number theory is dominated by several "grand challenges," among them the Riemann Hypothesis (RH). "There is renewed activity in RH," the appendix says, "but probably not at the depth needed." There are similar evaluations of eight other subfields: foundations, algebra and combinatorics, topology and geometric analysis, analysis, probability, applied mathematics, computational mathematics, and statistics.

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