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# Strengthening the Science and Mathematics Pipeline for a Better America

***As the nation's economic growth and national security depend increasingly on the science, technology, engineering, and mathematics (STEM) workforce, the United States must make a renewed commitment to math and science education.***

## Context

When the Soviet Union launched Sputnik in 1957, the United States felt an enormous threat to the future of the free world. To meet the urgent challenge of restoring America's scientific superiority, the federal government responded decisively with the 1958 National Defense Education Act, providing hundreds of millions of dollars (in today's dollars) to educate scientists and engineers. Today, there is no comparable immediate threat, but ongoing, significant erosion. As other nations of the world build up their scientific and technical infrastructures, they are challenging the United States' leadership role in science education and technological innovation.

Today's America is different from that of the 1950s and the nation must confront major obstacles that restrict the science and math pipeline. Many students are kept out of the pipeline due to poor teacher quality at the K-12 level and inadequate high school preparation in math and science, and these barriers are particularly strong for students of color. Others may be better prepared, but are dissuaded by long preparation and high tuition costs, low pay relative to fields such as law or business, and disappointing postsecondary experiences. For female students, a lack of role models and discouragement from pursuing science from an early age take their toll. And foreign talent increasingly has more places to go, as well as more difficulties coming to the United States.

The United States has been addressing many of these concerns, but needs to do more to strengthen the STEM pipeline.

## Observations

**Recent reports have shown the United States losing ground in the fields of science and**

**engineering.** Beginning in grade school, students are being outperformed in math and science by their counterparts in China, Japan and Singapore, with these trends continuing on into the high school years and college. While the number of U.S. students seeking bachelor's degrees in STEM fields has increased, the number of students pursuing and graduating with doctorates has decreased. Foreign scholars also are starting to find more enticing opportunities elsewhere.

**Trends in Graduate Applications, 1986 to 2004**

| Major Field | 2004 | Percent Change 2003 to 2004 | Average Annual Percent Change 1986 to 2004 |
|---|---|---|---|
| Biological Sciences | 77,070 | -14% | 3% |
| Engineering | 161,471 | -33% | 3% |
| Physical Sciences | 146,345 | -21% | 4% |

Source: *CGS/GRE Survey of Graduate Enrollment*

**Trends in Graduate Enrollment, 1986 to 2004**

| Major Field | 2004 | Percent Change 2003 to 2004 | Average Annual Percent Change 1986 to 2004 |
|---|---|---|---|
| Biological Sciences | 66,593 | 3% | 1% |
| Engineering | 105,767 | -3% | 2% |
| Physical Sciences | 105,518 | -1% | 1% |

Source: *CGS/GRE Survey of Graduate Enrollment*

Many experts have warned of an impending crisis in the STEM fields—not enough U.S. citizens studying and pursuing graduate degrees in these areas. The National Science Foundation reported that there is a decline in homegrown talent and an increasing reliance on foreign scholars to fill workforce voids. Additionally, the Bureau of Labor Statistics predicts that the number of jobs in science and engineering will grow by 47 percent—three times the rate of all occupations by the year 2010. The United States will likely not have enough talent to fill these positions and will be forced to look overseas.

But while the Council of Graduate Schools reports that the number of first-time enrollments of international students were up in 2004, the number that accepted admission to U.S. institutions went from 43 percent last year to 38 percent this year. Applications were also down by 33 percent in engineering, 21 percent in the physical sciences, and 14 percent in the biological sciences. Countries such as Australia are catering to students from China and India, who typically study science and engineering and pursue advanced degrees. The Council reported that between 2003 and 2004, enrollment of Chinese and Indian students at Australian universities increased from 13,056, to 47,911. In the United States, the number of students from those same countries increased by only 1,488, to 142,989. In addition, more stringent visa requirements are turning students off from the United States and on to countries with easier processes.

**To enlarge the domestic talent pool of interested and qualified students, the nation must improve science and math education. Primary objectives are improving K-12 math and science teaching, raising both the floor and the ceiling of high school preparation, and improving the undergraduate science experience.**

Despite substantial efforts over the past two decades to improve the quality of the K-12 teaching force, attracting and retaining sufficient numbers of high quality math and science teachers remains an elusive goal. (See *Policy Matters,* May 2005 at aascu.org/policy_matters/pdf/v2n5.pdf.) The federal government must continue its support of programs to improve teacher education in STEM areas, supporting teacher and faculty development and increasing institutional capacity.

Similarly, despite widespread efforts over past decades to improve high school preparation for college, the United States lags behind others in recognizing the sequential nature of most STEM fields and the need to prepare early and continuously for demanding college-level and postgraduate studies. In recent years, states have increased the number and rigor of math and science courses required for high school graduation, and there has been growth in the availability of Advanced Placement and dual enrollment options. These are positive but piecemeal developments. (See *Perspectives,* July 2005 at aascu.org/pdf/05_perspectives.pdf.) Success will be limited unless enough qualified teachers are available to staff the advanced coursework.

Colleges also play a critical role in making introductory science and math courses more attractive to "undecided" students, and in better engaging those who have chosen to major in STEM fields. Institutions need to incorporate more active learning strategies, tutoring and counseling, and expanded research opportunities throughout the college experience. Faculty roles and reward structures should also be examined.

**Additional incentives—both financial and non-financial—are needed to recruit available talent into the STEM pipeline and to retain STEM students and workers.**

Preparation for a science career does not come cheap, nor does it come quickly. To the extent that financial concerns can be reduced, more students will opt for a science career and more STEM teachers and faculty will remain on the job. The federal government currently provides scholarships and loan forgiveness specifically for science and math students, and recommendations have been put forth for expansion of these programs. Many states offer such programs as well. In terms of K-12 teachers, differentiated pay structures that offer higher pay for science and math teachers have been initiated in some places, as have signing bonuses, tuition reimbursement, and loan forgiveness. Retaining university faculty members remains a challenge, since many of these individuals can earn much more in the private sector.

Preparation for a science career may not come naturally either. All students, but particularly underrepresented minorities and women, need encouragement to pursue science activities from an early age, and continued support and mentoring through the pipeline. Outreach to middle and high school students, for example, in the form of summer internships and research opportunities on college campuses, may stimulate interest. Universities also need to communicate information on preparing for a career in science and on the diverse jobs that are available, and to offer welcoming environments.

**To fill the gap in the STEM workforce, the United States needs to increase its recruiting efforts of international students around the world. Visa and immigration policies need to help and encourage, not hinder, students and scholars to seek their education and employment in this country.**

The United States has been a long-standing leader in recruiting foreign students and for the past six years has seen more than a half a million students enter its borders each year to study at the nation's colleges and universities. A combination of factors, including stringent security and visa requirements, the creation of the Student and Exchange Visitor Information System (SEVIS), a downturn in the world's economy and increased global competition, have eroded these numbers slightly. The visa process has been a particular hindrance to students and scholars studying nuclear, biomedical, or computer technology. Every applicant must be interviewed for 90 seconds and undergo a security clearance known as Visa Mantis, meant to protect against sensitive technology transfers. While these policies are beginning to change, numerous reports indicate this to be one of the biggest obstacles for foreign students.

In addition, some international students are seeking their education and employment in countries such as Australia, Canada and Singapore that are noting the benefits of increasing international enrollments and are working collaboratively to liberalize visa policies and create aggressive strategies to entice students to their colleges and universities. The United States must move quickly to stay on top of the recruiting game by developing comprehensive strategies to boost enrollments of coveted STEM students through innovative programs, financial incentives and a more inviting visa policy.

## Conclusion

The federal government has the primary responsibility to support STEM education and must take the lead in encouraging states, private industry, and higher education to reaffirm commitment to these programs of study and workforce opportunities. The United States has begun, spending $2.8 billion dollars in Fiscal Year 2004 for 207 programs designed to increase the numbers of students and graduates or to improve educational programs in STEM fields. However, the nation lacks an overall strategy and the coordination of federal STEM programs has been limited. In 2003, the National Science and Technology Council Committee on Science established a subcommittee on education and workforce development to coordinate these programs that represents a step in the right direction. But more and earlier efforts need to be mounted, teaching all ages the value of science, technology, engineering, and math and helping them see the benefits of careers in these disciplines. This is a long-term and lofty goal that may take years to see results.

## Resources


***Data sources***

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**National Science Foundation,** *Science and Engineering Indicators, 2004.* nsf.gov/statistics/seind04/

***Policy reports***

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