

A Synthesis of Recommendations for Improving U.S. Science and Mathematics Education

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Introduction

The year 2005 saw a number of reports calling for actions to ensure the future economic vitality of the United States, frequently through the improvement of science and mathematics education. This trend will likely continue into 2006 as policymakers at the state and federal levels look for ways to ensure the United States remains economically competitive and secure in the emerging 21st century economy.

The challenges cited are fairly consistent, commonly including:

- Increased economic competition from other nations, particularly China and India
- A dependence on foreign-born talent that may not be sustainable
- A shortage of qualified mathematics/science teachers
- A shortage of U.S. students studying for mathematics/science degrees.

Groups issuing these reports represent a diverse cross-section of interests, including the business, higher education and policy worlds – and their intended audiences are similarly diverse. This document provides a brief summary of the major recommendations of six relevant reports. The table below indicates which reports shared recommendations in some of the more commonly cited areas of need. Although every effort was made to capture the essence of each report's recommendations, interested readers are encouraged to follow the included hotlinks and read the reports in their entirety. (For print readers of this document, text for hotlinks is provided at the end of the document.)

Summary Table (*click on report title at left for individual summary*)

	Engage Public	Increase STEM Degrees Earned	Outreach to Minorities or Economically Disadvantaged	Teacher Recruitment, Education, Professional Development	Research + Innovation	Visa / Immigration Reforms
Keeping America Competitive: Five Strategies To Improve Mathematics and Science Education	X		X	X		
National Defense Education and						

	Engage Public	Increase STEM Degrees Earned	Outreach to Minorities or Economically Disadvantaged	Teacher Recruitment, Education, Professional Development	Research + Innovation	Visa / Immigration Reforms
Innovation Initiative: Meeting America's Economic and Security Challenges in the 21st Century		X	X	X	X	X
Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future		X		X	X	X
Statement of the National Summit on Competitiveness: Investing in U.S. Innovation		X		X	X	X
Tapping America's Potential: The Education for Innovation Initiative	X	X	X	X	X	X
Waiting for Sputnik					X	

Report Summaries

[Keeping America Competitive: Five Strategies To Improve Mathematics and Science Education](#) (Education Commission of the States, July 2005)

Improving mathematics and science education in the United States belongs near the top of the policymaking agenda. America's role as a leader in the world's economy and its capacity to produce wealth and quality jobs for its future citizens depend directly on the ability of our education system to produce students who can compete in the math- and science-dominated industries of the future.

Suggested Strategies:

Strengthen math and science assessments:

- The National Science and Mathematics Standards should be analyzed to find those core elements that student assessments might be linked around.
- The National Science and Mathematics Standards should be used to make appropriate changes to textbook and curriculum materials.
- Tests must be developed to measure both subject knowledge and overall student understanding of math and science concepts.

Ensure teachers have adequate knowledge and skills:

- Education leaders and schools of education must draw on the nearly two decades of research addressing the knowledge and skills needed to teach math effectively.
- Researchers and policymakers should work to develop more studies on the knowledge and skills needed to teach science effectively.
- Research findings should be used to revise and improve teacher education, training and professional development programs.

Give the neediest students the best teachers:

- Offer higher pay for math and science teachers who serve in hard-to-staff schools.
- Provide strong mentoring and induction programs for all new teachers.
- Develop cross-district programs that encourage experienced teachers to teach for several years in an urban district without risking loss of their seniority, pension or pay privileges if they return to their original district.
- Develop accommodations with teacher unions that promote incentives for math and science teachers to work in hard-to-staff schools.

Enlist the entire university in the effort to improve teacher education:

- Ensure that original research is connected to what policymakers need. Compensation, tenure and career-advancement incentives should be given to researchers whose work is most useful to policymakers.
- Identify promising ways of attracting talented students to become math and science teachers.
- Connect more math and science teachers with university researchers.
- Make it clear the responsibility for preparing teachers rests not just with the school of education, but with the institution as a whole – especially the arts and sciences faculty.
- Ensure graduates of education programs are supported, mentored and tracked over time.
- Review teacher education programs, focusing on:
 - The extent to which prospective teachers are grounded in the academic content area in which they will teach, proven practical teaching skills and using technology in the classroom
 - The quality of students admitted to the program. Admission and performance standards for students in teacher education programs should match or exceed those of the student body as a whole
 - The steps that teacher education programs are taking to attract and retain talented minority students.

Engage the greater public:

- Develop a series of clear messages that resonate with the public and with policymakers on the need to improve mathematics and science education.
- Engage communications specialists to translate research findings into materials that resonate with the public, policymakers, parents and young people who may choose to become tomorrow's math and science teachers.
- Engage the business community in sending an urgent message to policymakers and the public of the importance of math and science education to the U.S. economy.
- Engage university presidents and educators as visible, vocal advocates for improving science and math education at all levels.

National Defense Education and Innovation Initiative: Meeting America's Economic and Security Challenges in the 21st Century (Association of American Universities, January 2006)

Key Recommendations for Universities and Colleges:

Enhance research and innovation:

- Strengthen the connections between campus-based research and undergraduate education.
- Establish interdisciplinary research and education initiatives that create new combinations of faculty, postdoctoral fellows (postdocs) and graduate and undergraduate students to address emerging national challenges.
- Provide top young scientists and engineers – postdocs and junior faculty – with independent research opportunities and funding to encourage novel thinking and research.

Cultivate American talent:

- Identify and promote best practices and programs in undergraduate STEM (science, technology, engineering and mathematics) and foreign language education, especially those that address college freshman attrition and under-representation of minorities and women in STEM fields.
- Continue reexamination of doctoral education, particularly in STEM and language disciplines, to develop ways to shorten time to degree, improve completion rates and broaden the scope of Ph.D. education.
- Continue to establish and build on professional science masters programs that meet specific science and technical managerial workforce needs identified by the federal government, business and industry.
- Provide more university research experiences for those training to be K-12 math and science teachers, and for current teachers.
- Create accelerated teacher certification programs for individuals with STEM, foreign language or area studies expertise.
- Create and sustain stronger partnerships with school districts, state departments of education and business that focus on training and retraining K-12 teachers to fill the current teacher skills and knowledge gaps in STEM and foreign language education.

Attract and retain foreign talent:

- Continue to work with Congress and the Administration to combat the misperception that international students, scholars, scientists and engineers are no longer welcome in the U.S.
- Continue to work with the departments of State and Homeland Security to improve the visa process so that bona fide international students, scholars, scientists and engineers can enter the U.S. in a secure, timely and efficient manner.

Key Recommendations for Government:

Enhance research and innovation:

- Increase federal investment in basic research supported by the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and the departments of Energy (DOE), Defense (DOD), Homeland Security (DHS), and Commerce by 10 % annually for the next seven years placing particular emphasis upon growing federal support for the physical sciences and engineering. Grow investment thereafter to continue driving innovation.
- Sustain basic medical science funding at historical rates of growth to preserve the biomedical research capacity made possible by the recent doubling of the National Institutes of Health (NIH) budget.
- Strengthen federal support for research infrastructure by reinvigorating competitive facilities and equipment programs at the NIH and NSF, adequately funding the Department of Energy's 20-

year facilities plan, and examining policy changes to strengthen federal support for scientific infrastructure at universities.

Cultivate American talent:

- Increase by 5,000 the number of graduate fellowships and traineeships supported by existing programs at federal science and education agencies, including NSF, NIH, NASA, and the departments of Defense, Homeland Security, Energy, and Education.
- Create a graduate fellowship and traineeship program in the DOE Office of Science that supports 1,000 students annually and that generates talent to help achieve energy self-sufficiency and enhance the nation's scientific enterprise.
- Expand the DOD National Defense Education Program, which provides scholarships and fellowships to students in critical fields of science, mathematics and engineering in return for a commitment of national service after their studies.
- Increase federal need-based student aid, especially Pell Grants, to make college possible for the neediest students.
- Build on the Administration's National Security Language Initiative by expanding federal foreign language, area studies and study abroad programs.
- Revive the National Defense Education Act (NDEA) K-12 teacher skills summer workshops to help teachers of math, science, and foreign languages improve their teaching skills and meet teaching standards.
- Improve education research and K-12 education by creating: (1) a competitively awarded extramural grant program in the Institute of Education Sciences at the Department of Education that funds high-quality research on K-12 education; and (2) a new graduate fellowship program that supports 500 students per year pursuing Ph.D.s in math and science education.
- Establish a new mentoring and tutoring program in which college students earn a stipend for tutoring K-12 students in STEM and foreign language coursework.

Attract and retain foreign talent:

- Reform immigration policies to create clear pathways to permanent residency and U.S. citizenship for top international students who earn U.S. degrees, as well as outstanding scientists and engineers in the U.S. on exchange or work visas.
- Ensure that government policies and contracting practices do not discriminate against or curtail participation by international students and scientists in the conduct of unclassified fundamental research.

[Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future](#) (National Academies Press, October 2005)

Although primarily aimed at federal policymakers, many of the proposals contain components that state policymakers could implement on their own – and in many cases already have.

10,000 Teachers for 10 Million Minds

Simply stated, teachers are the key to improving student performance.

The first overall recommendation in the report proposes three major actions in K-12 education:

10,000 teachers for 10 million minds:

Proposed Action: Annually recruit 10,000 science and mathematics teachers by awarding four-year scholarships and thereby educating 10 million minds.

A quarter of a million teachers inspiring young minds every day:

Proposed Action: Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in Master's programs, and Advanced Placement and International Baccalaureate (AP and IB) training programs and thus inspire students every day.

Expand the pipeline:

Proposed Action: Enlarge the pipeline by increasing the number of students who take AP and IB science and mathematics courses.

Best and the Brightest

Make the United States the most attractive setting in which to study and perform research, so that we can develop, recruit and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.

Best and the Brightest addresses actions in higher education, proposing action in four areas:

Undergraduate education:

Increase the number and proportion of U.S. citizens who earn physical-sciences, life-sciences, engineering and mathematics bachelor's degrees by providing 25,000 new four-year competitive undergraduate scholarships each year to U.S. citizens attending U.S. institutions.

Graduate education:

The federal government should fund Graduate Scholar Awards in Science, Technology, Engineering or Mathematics (GSA-STEM), a new scholarship program that would provide 5,000 new, portable three-year competitively awarded graduate fellowships each year for outstanding U.S. citizens pursuing science, mathematics and engineering programs. Portable fellowships would provide funds directly to students, who would choose where they wish to pursue graduate studies instead of having to follow faculty research grants.

Continuing education:

To keep practicing scientists and engineers current with rapidly changing science and technology, the federal government should provide tax credits – up to \$500 million each year – to employers who help their eligible employees pursue continuing education.

International students and scholars:

To create the most attractive setting for study, research and commercialization – and to attract the international students and scholars who contribute significantly to our research innovation enterprise – the U.S. government must revise its policies and procedures for granting visas, implement a new skill-based preferential immigration option, increase the permissible time for Ph.D. graduates to obtain employment, provide appropriate access to technical information and equipment, and fund graduate education and research for outstanding foreign nationals.

Statement of the National Summit on Competitiveness: Investing in U.S. Innovation (The National Summit on Competitiveness, December 2005)

The National Summit on Competitiveness has one fundamental and urgent message: If trends in U.S. research and education continue, our nation will squander its economic leadership, and the result will be a lower standard of living for the American people.

Three proposed major tasks to address the challenge:

Revitalize fundamental research:

- Increase the federal investment in long-term basic research by 10% a year over the next seven years with focused attention to the physical sciences, engineering and mathematics.
- Allocate at least 8% of the budgets of federal research agencies to discretionary funding focused on catalyzing high-risk, high-payoff research.

Expand the innovation talent pool in the United States:

- By 2015, double the number of bachelor's degrees awarded annually to U.S. students in science, math and engineering, and increase the number of those students who become K-12 science and math teachers.
- Reform U.S. immigration policies to enable the education and employment of individuals from around the world with the knowledge and skills in science, engineering, technology and mathematics necessary to boost the competitive advantage of the United States.
- Provide incentives for the creation of public-private partnerships to encourage U.S. students at all levels to pursue studies and/or careers in science, math, technology and engineering.

Lead the world in the development and deployment of advanced technologies:

- Provide focused and sustained funding to address national technology challenges in areas that will ensure national security and continued U.S. economic leadership, including nanotechnology, high-performance computing and energy technologies.

Tapping America's Potential: The Education for Innovation Initiative (The Business Roundtable, July 2005)

Our organizations feel strongly that the United States must respond to this challenge as energetically as we did to the Soviet Union's launching of Sputnik in the 1950s. To remain the technological leader in the 21st century, we must establish and achieve an ambitious goal: We must double today's science, technology, engineering and mathematics graduates with bachelor's degrees by 2015.

Summary of Recommendations (sector indicated as having primary responsibility for implementation):

- Build public support for making science, technology, engineering and math improvement a national priority (business).
- Motivate U.S. students and adults to study and enter science, technology, engineering and mathematics careers, with a special effort geared to those currently in underrepresented groups (federal government, state governments, higher education, business and districts.)
- Upgrade K-12 math and science teaching to foster higher student achievement (federal government, state governments, higher education, business and districts.)
- Reform visa and immigration policies to enable the United States to attract and retain the best and brightest science, technology, math and engineering students from around the world to study for advanced degrees and stay to work in the United States (federal government).
- Boost and sustain funding for basic research, especially in the physical sciences and engineering (federal government).

Waiting for Sputnik (The Center for Strategic and International Studies, October 2005)

If there is one point we hope you take away from Waiting for Sputnik, it is that the underfunding of basic research in physics, math and engineering is not a problem for science policy or business, but a major challenge for the future security of the United States.

Summary of Recommendations:

- Restore funding for basic research in the physical sciences and engineering across all domestic non-defense research agencies to the levels needed to meet long-term economic and national security requirements.
- Commit a larger proportion of defense spending within current research, development, testing and evaluation funding levels to basic research and science and technology workforce development.
- Establish new mechanisms for partnerships with the private sector, other agencies and other governments – including both the state governments within the U.S. and allied governments outside – to support university research.

- Create new governmental funding vehicles – such as special purpose bonds, investment incentives or endowments – to leverage current federal allocations.

Text of Hotlinks:

Education Commission of the States, *Keeping America Competitive: Five Strategies To Improve Mathematics and Science Education*, July 2005: <http://www.ecs.org/clearinghouse/62/19/6219.pdf>

Association of American Universities, *National Defense Education and Innovation Initiative: Meeting America's Economic and Security Challenges in the 21st Century*, January 2006:
<http://www.aau.edu/reports/NDEII.pdf>

National Academies Press, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, October 2005:<http://fermat.nap.edu/catalog/11463.html>

The National Summit on Competitiveness, *Statement of the National Summit on Competitiveness: Investing in U.S. Innovation*, December 2005:
http://www.usinnovation.org/pdf/National_Summit_Statement.pdf

The Business Roundtable, *Tapping America's Potential: The Education for Innovation Initiative*, July 2005: <http://www.businessroundtable.org/pdf/20050803001TAPfinalnb.pdf>

The Center for Strategic and International Studies, *Waiting for Sputnik*, 2005:
http://www.csis.org/media/csis/pubs/051028_waiting_for_sputnik.pdf

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