Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future

Concerning
American Competitiveness Initiative
Science and Math Education Provisions

Statement of

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And

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Committee on Science, Engineering, and Public Policy
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The National Academies

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Committee on Appropriations
U.S. House of Representatives

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Mr. Chairman and members of the Committee.

Thank you for this opportunity to appear before you on behalf of the National Academies' Committee on Prospering in the Global Economy of the 21st Century. As you know, our effort was sponsored by the National Academy of Sciences, National Academy of Engineering and Institute of Medicine (collectively known as the National Academies). The National Academies were chartered by Congress in 1863 to advise the government on matters of science and technology.

During my testimony, I will focus on the challenges that we are facing in K through 12 education. The committee believes the education issue is the most critical challenge the United States is facing if our children and grandchildren are to inherit ever-greater opportunities for high-quality, high-paying jobs. Our solution and recommendations to respond to the nation's challenge in K—12 science and mathematics education are the committee's top priority.

In examining the issue of K—12 science and mathematics education, the committee found facts such as the following:

- Fewer than one-third of US 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations.[i]

- In 1995 (the most recent data available), US 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.[ii]

- US 15-year-olds ranked 24th out of 40 countries that participated in a 2003 administration of the Program for International Student Assessment (PISA) examination, which assessed students' ability to apply mathematical concepts to real-world problems.[iii]

- In 1999, 68% of US 8th grade students received instruction from a mathematics teacher who did not hold a degree or certification in mathematics.[iv]

- In 2000, 93% of students in grades 5-9 were taught physical science by a teacher lacking a major or certification in the physical sciences (chemistry, geology, general science, or physics).[v]

- According to a recent survey, 86% of US voters believe that the United States must increase the number of workers with a background in science and mathematics or America's ability to compete in the global economy will be diminished.[vi]

- American youth spend more time watching television[vii] than in school.[viii]

- Because the United States does not have a set of national curricula, changing K-12 education is challenging, given that there are almost 15,000 school systems in the United States and the average district has only about 6 schools.[ix]

The committee then made the recommendation we call "10,000 Teachers, 10 Million Minds" which proposes increasing America's talent pool by vastly improving K—12 science and mathematics education.

In developing its action steps to reach this goal, the committee first focused on what part of K—12 science and mathematics education was of greatest concern. The committee's proposed actions in this area fall into three categories: recruiting new teachers, enhancing the skills of existing teachers, and enlarging the pipeline of students who are prepared to enter college and graduate with a degree in science, mathematics, engineering, or computer science.

Of all its 20 action steps, the committee's highest priority is a program that would annually recruit 10,000 of America's brightest students to the K–12 science and mathematics teaching profession. The program would recruit and train excellent teachers by providing scholarships to students obtaining bachelor's degrees in science, technology, engineering, or mathematics while gaining concurrent certification as K–12 science and mathematics teachers. They would accomplish this by taking some pedagogy courses along with their major courses. Over their careers each of these teachers

would educate 1,000 students, so that each annual cadre of teachers educated in this program would impact 10 million minds.

The program would provide merit-based scholarships of up to $20,000 a year for 4 years for qualified educational expenses, including tuition and fees, and would require a commitment to 5 years of teaching service in public K–12 schools. A $10,000 annual bonus would go to program graduates working in underserved schools in inner cities and rural areas.

To provide the highest-quality education for undergraduates who want to become K–12 science and mathematics teachers, it would be important to award matching grants, perhaps $1 million a year for up to 5 years, to as many as 100 universities and colleges to encourage them to establish integrated 4-year undergraduate programs leading to bachelor's degrees in science, engineering, or mathematics *with concurrent teacher certification*.

This program, modeled after a very successful program in Texas (and which is being replicated in California), takes advantage of those people who are already in science, mathematics, engineering, and technology higher education programs and offers them the ability to get into teaching. It also incorporates in-classroom teaching experiences, master K-12 teachers, and ongoing mentoring—the combination of which produces highly qualified teachers with the skills and support to remain effective in the classroom. The estimated cost of this program in FY 2007 is $110 million.

Our second action step focuses on strengthening the skills of 250,000 current K–12 science and mathematics teachers through summer institutes, Master's programs, and Advanced Placement and International Baccalaureate (AP and IB) professional development programs. Each of these activities also builds on very successful model programs that can be scaled up to the national level.

In the case of the summer institutes, the committee recommends that the federal government provide matching grants for state-wide and regional 1- to 2-week summer institutes to upgrade the content knowledge and pedagogy skills of as many as 50,000 practicing teachers each summer. The material covered would allow teachers to keep current with recent developments in science, mathematics, and technology and allow for the exchange of best teaching practices. The Merck Institute for Science Education for K-6 teachers is a model for this recommendation. The estimated cost of this program in FY 2007 is $40 million.

For the science and mathematics master's programs, the committee recommends that the federal government provide grants to universities to develop and offer 50,000 current middle-school and high-school science, mathematics, and technology teachers (with or without undergraduate science, mathematics, or engineering degrees) 2-year, part-time master's degree programs that focus on rigorous science and mathematics content and pedagogy. This program's master's teachers would provide leadership for all the programs included in our K-12 science and mathematics education recommendation. Teachers who complete this program would receive federally-funded $10,000 stipends annually for up to 5 years provided they remain in the classroom and engage in teacher leadership activities. Once the 5-year limit has been reached, teachers could pursue national certification for which many states offer a financial basis. The model for this recommendation is the University of Pennsylvania Science Teachers Institute. The estimated cost of this program in FY 2007 is $46 million.

The committee recommends that the federal government support the training of an additional 70,000 AP or IB and 80,000 pre-AP or pre-IB instructors to teach advanced courses in mathematics and science. Assuming satisfactory performance, teachers may receive incentive payments of up to $2000 per year, as well as $100 for each student who passes an AP or IB exam in mathematics or science. There are two models for this program: the Advanced Placement Incentive Program and Laying the Foundation, a pre-AP program. The estimated cost of the AP-IB Teacher Incentives program in FY 2007 is $100 million.

These teachers would then participate in our proposed program that would create opportunities and incentives for middle school and high school students to pursue advanced work in science and mathematics. The committee recommends that the number of students who take at least one AP or IB mathematics or science exam should be increased to 1.5 million by 2010. The committee also recommends setting a goal of tripling the number of students who pass those tests to 700,000. Students would receive incentives to both take and pass the exam including a rebate of 50% of their examination fee and a $100 mini-scholarships for each passing score on an AP or IB science or mathematics examination. The estimated cost of the AP-IB Student Incentives program in FY 2007 is $60 million.

Why are we doing this? Because many of the science and mathematics teachers who are teaching these subjects have no background in the subjects that they are teaching. It is very hard for someone who does not have a physics education to turn students on to physics, because many lack a fundamental understanding of the subject. Teachers with strong content knowledge, either through a bachelors or Masters program, who also have strong pedagogy skills and access to ongoing skills updates can be truly effective in encouraging students to enter science, mathematics, and technology fields.

The committee also proposes that high-quality teaching be fostered with world-class curricula, standards, and assessments of student learning. Here, the committee recommends that the Department of Education convene a national panel to collect, evaluate, and develop rigorous K–12 materials that would be available free of charge as a *voluntary* national curriculum.

The model for this recommendation is Project Lead the Way (PLTW)—a national program with partners in public schools, colleges and universities, and the private sector. PLTW is now offered in 45 states and the District of Columbia. The project has developed a 4-year sequence of courses that, when combined with college preparatory mathematics and science, introduces students to the scope, rigor, and discipline of engineering and engineering technology. PLTW also has developed a middle school technology curriculum, Gateway to Technology. Students participating in PLTW courses are better prepared for college engineering programs than those exposed only to the more traditional curricula. Comprehensive teacher education is a critical component of PLTW, and the curriculum uses cutting-edge technology and software that require specialized education. Continuing education supports teachers as they implement the program and provides for continuous improvement of skills. The estimated cost of this program in FY 2007 is $20 million.

The committee also identified two additional approaches to improving K-12 science and mathematics education that are already in use—statewide specialty schools and inquiry-based learning—that it believed could be expanded.

Statewide specialty high schools are an effective way to increase student achievement in science and mathematics by providing an intensive learning experience for high-performing students. These schools immerse students in high-quality science and mathematics education, serve as testing grounds for

curricula and materials, provide in-classroom educational opportunities for K–12 teachers, and have the resources and staff for summer programs to introduce students to science and mathematics.

One model for this program is the North Carolina School of Science and Mathematics (NCSSM), which opened in 1980. NCSSM enrolls juniors and seniors from most of North Carolina's 100 counties. NCSSM's unique living and learning experience made it the model for 16 similar schools around the world. It is the first school of its kind in the nation—a public, residential high school where students study a specialized science and mathematics curriculum. At NCSSM, teachers come for a "sabbatical year", and the school has a structure and the personnel it needs to offer summer institutes for outstanding students.

Inquiry-based learning such as summer research programs stimulate student interest and achievement in science, mathematics, and technology should be encouraged—particularly those designed to stimulate low-income and minority student participation. These programs frequently involve several institutions or public–private partnerships

The committee is pleased that the President's American Competitiveness Initiative is harmonious with our recommendations and that it proposes actions for educating a new workforce with up-to-date knowledge in science and engineering. We are particularly pleased that the American Competitiveness Initiative includes the "Expanded Advanced Placement Incentive Program" which has the goal of training 70,000 additional AP and IB math, science, and critical language teachers and drastically increasing the number of students taking AP-IB courses and tripling the number of students passing AP-IB tests to 700,000 by 2012.

By taking the actions proposed in the National Academies Gathering Storm report, we believe that the United States will be better positioned to compete as a country for high-quality, high-paying jobs for all Americans.

Thank you for providing me with this opportunity to testify before the committee. I would be pleased to answer any questions you have about the report.

NANCY S. GRASMICK

Dr. Nancy Grasmick is Maryland's first female state superintendent of schools. She has served in that post since 1991. Dr. Grasmick's career in education began as a teacher of deaf children at the William S. Baer School in Baltimore City. She later served as a classroom and resource teacher, principal, supervisor, assistant superintendent, and associate superintendent in the Baltimore County Public Schools.

In 1989, she was appointed special secretary for children, youth, and families, and in 1991, the state Board of Education appointed her state superintendent of schools.

Dr. Grasmick holds a PhD from the Johns Hopkins University, an MS from Gallaudet University, and a BS from Towson University. She has been a teacher, an administrator, and a child advocate.

Her numerous board and commission appointments include the President's Commission on Excellence in Special Education, the US Army War College Board of Visitors, the Towson University Board of Visitors, the state Planning Committee for Higher Education, and the Maryland Business Roundtable for Education. Dr. Grasmick has received numerous awards for leadership, including the Harold W. McGraw, Jr. Prize in Education.

Notes:

[i] National Center for Education Statistics.. (2006), "The Nation's Report Card: Mathematics 2005." See http://nces.ed.gov/nationsreportcard/pdf/main2005/2006453.pdf
[ii] National Center for Education Statistics (1999), *Highlights from TIMSS* http://nces.ed.gov/pubs99/1999081.pdf.
[iii] National Center for Education Statistics (2005), "International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results from the U.S. Perspective," pp. 15 & 29 (http://nces.ed.gov/pubs2005/2005003.pdf).
Notes:

[iv] National Science Board. 2004. *Science and Engineering Indicators 2004* (NSB 04-01). Arlington, VA: National Science Foundation. Chapter 1.
[v] National Center for Education Statistics (2004), Schools and Staffing Survey, 2004. "Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987-88 to 1999-2000 (Revised)," p. 10 (http://nces.ed.gov/pubs2002/2002603.pdf)
[vi] The Business Roundtable. 2006. "Innovation and U.S. Competitiveness: Addressing the Talent Gap. Public Opinion Research." January 12. Available at: http://www.businessroundtable.org/pdf/20060112Two-pager.pdf
[vii] American Academy of Pediatrics. "Television- How it Affects Children." Available at http://www.aap.org/pubed/ZZZGF8VOQ7C.htm?&sub_cat=1 The American Academy of Pediatrics reports that "Children in the United States watch about four hours of TV every day"; this works out to be 1460 hours per year.
[viii] National Center for Education Statistics. 2005. *The Condition of Education*. Table 26-2 Average Number of Instructional Hours Per Year Spent in Public School, By Age or Grade of Student and Country: 2000 and 2001. Available at http://nces.ed.gov/programs/coe/2005/section4/table.asp?tableID=284. NCES reports that in 2000 US 15 year-olds spent 990 hours in school, during the same year 4th graders spent 1040 hours.
[ix] National Center for Education Statistics (2006), "Public Elementary and Secondary Students, Staff, Schools, and School Districts: School Year 2003–04" .http://nces.ed.gov/pubs2006/2006307.pdf.