America COMPETES Act: Programs, Funding, and Selected Issues

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April 17, 2009

Congressional Research Service
7-5700
www.crs.gov
RL34328

CRS Report for Congress
Prepared for Members and Committees of Congress

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
17 APR 2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
America COMPETES Act: Programs, Funding, and Selected Issues	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Congressional Research Service,Library of Congress,101 Independence Ave, SE,Washington,DC,20540-7500**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**70**	

Summary

The America COMPETES Act (P.L. 110-69) became law on August 9, 2007. The act responds to concerns that the United States may not be able to compete economically with other nations in the future due to insufficient investment today in science and technology research and science, technology, engineering, and mathematics (STEM) education and workforce development. The America COMPETES Act is intended to increase the nation's investment in science and engineering research and in STEM education from kindergarten to graduate school and postdoctoral education. It is designed to focus on two perceived concerns believed to influence future U.S. competitiveness: inadequate research and development funding to generate sufficient technological progress, and inadequate numbers of American students proficient in science and mathematics or interested in science and engineering careers relative to international competitors.

The act authorizes funding increases for the National Science Foundation (NSF), National Institute of Standards and Technology (NIST) laboratories, and the Department of Energy (DOE) Office of Science over FY2008-FY2010. If maintained, the increases would double the budgets of those entities over seven years. The act establishes the Advanced Research Projects Agency – Energy (ARPA-E) within DOE, designed to support transformational energy technology research projects with the goal of enhancing U.S. economic and energy security. A new program, Discovery Science and Engineering Innovation Institutes, would establish multidisciplinary institutes at DOE National Laboratories to "apply fundamental science and engineering discoveries to technological innovations," according to the act.

Among the act's education activities, many of which are focused on high-need school districts, are programs to recruit new K-12 STEM teachers, enhance existing STEM teacher skills, and provide more STEM education opportunities for students. The new Department of Education (ED) Teachers for a Competitive Tomorrow and existing NSF Robert Noyce Teacher Scholarship programs provide opportunities, through institutional grants, for students pursuing STEM degrees and STEM professionals to gain teaching skills and teacher certification, and for current STEM teachers to enhance their teaching skills and understanding of STEM content. The act also authorizes a new program at NSF that would provide grants to create or improve professional science master's degree (PSM) programs that emphasize practical training and preparation for the workforce in high-need fields.

The America COMPETES Act is an authorization act. New programs established by the act will not be initiated and authorized increases in appropriations for existing programs will not occur unless funded through subsequent appropriation acts. The 110th Congress provided FY2008 appropriations to establish ED's Teachers for a Competitive Tomorrow program, and NIST's Technology Improvement Program (TIP), which replaced the existing Advanced Technology Program. The 111th Congress provided FY2009 appropriations to establish DOE's ARPA-E and NSF's PSM program. Although some America COMPETES Act research and STEM education programs received appropriations at or above authorized levels in FY2009, others did not.

As Congress deliberates the FY2010 budget, an issue for Congress is what level, if any, will it provide America COMPETES Act programs an appropriation, and whether or not the President's budget request will propose to do so. Several programs newly authorized in the act have never been appropriated funds. An issue for these programs is whether or not they will receive the funding necessary to establish them. The America COMPETES Act provides authorization levels only through FY2010.

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On August 2, 2007, Congress passed the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act or the America COMPETES Act (H.R. 2272), which President Bush signed into law (P.L. 110-69) on August 9, 2007. The America COMPETES Act had substantial bipartisan support passing 367-57 in the House and by unanimous consent in the Senate.

The America COMPETES Act is intended to increase the nation's investment in science and engineering research, and in science, technology, engineering, and mathematics (STEM) education from kindergarten to graduate school and postdoctoral education. The act is designed to focus on two perceived concerns believed to influence future U.S. competitiveness: inadequate research and development funding to generate sufficient technological progress, and inadequate numbers of American students proficient in science and mathematics or interested in science and engineering careers relative to international competitors.

The act is an authorization act, so new programs established by the act will not be initiated unless funded through subsequent appropriations.[1] Similarly, increases in the authorization level of existing programs may or may not translate into increased funding.

This report provides an overview of the America COMPETES Act provisions, summarizes its legislative origin and the origins of some of the new programs it authorizes, analyzes selected America COMPETES Act programs that are the focus of appropriation discussions, and provides a comparison of the President's budget, congressional appropriations, and America COMPETES Act authorization levels for FY2008. **Appendix A** provides an overview of the act's legislative history. **Appendix B** provides a summary of all the provisions of the act.

Overview of America COMPETES Act

The America COMPETES Act (P.L. 110-69) has eight titles that authorize programs and activities at the White House Office of Science and Technology Policy (OSTP), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), the Department of Education (ED), the National Science Foundation (NSF), and the Department of Commerce's National Institute of Standards and Technology (NIST), and National Oceanic and Atmospheric Administration (NOAA).

Among its provisions, the act authorizes the following:

Research

- Funding of research supported by NIST, the DOE Office of Science, and the NSF for FY2008-FY2010 at a rate that, if sustained, would double these agencies' research budgets over seven years;
- Early career and new investigator grants for science, engineering, and mathematics researchers at DOE and NSF;

[1] For a discussion of the authorization/appropriations process, see CRS Report RS20371, *Overview of the Authorization-Appropriations Process*, by Bill Heniff Jr.

- A new Advanced Research Projects Agency-Energy (ARPA-E)[2] in DOE that would sponsor transformational energy technology research projects; and
- New Discovery Science and Engineering Innovation Institutes at DOE National Laboratories, which are multidisciplinary institutes that are intended to apply fundamental science and engineering discoveries to technological innovations.

Education

- Scholarship and training programs to recruit new K-12 STEM teachers who would simultaneously earn STEM degrees plus teacher certification, and enhance the skills of existing STEM teachers through a variety of activities administered by the DOE, NASA, NSF, and ED;
- Student-focused STEM programs at ED, DOE, and NSF including Math Now for elementary and middle school students, grants to states for public, statewide, specialty, secondary schools in science and mathematics, Advanced Placement (AP) or International Baccalaureate (IB) courses at the high school level, scholarships and fellowships for undergraduate and graduate students, and enhanced mentoring for postdoctoral scholars;
- New STEM education activities at ED, DOE, and NSF including establishment of a summer term educational program focused on mathematics, technology, and problem-solving at ED; a Director of Science, Engineering, and Education position, National Laboratory educational activities, and graduate fellowship program at DOE; and a professional science master's program and high school laboratory program at NSF.

The act also includes White House efforts, under OSTP, to foster innovation and competitiveness activities including a National Science and Technology Summit, National Technology and Innovation Medal, and President's Council on Innovation and Competitiveness.

Overview of U.S. Competitiveness Initiatives

For the nation to maintain economic growth and a high standard of living, the United States must be competitive in a global economy. To be competitive, U.S. companies must engage in trade, retain market shares, and offer high quality products processes and services. Scientific and technological advances can further economic growth because they contribute to the creation of new goods, services, jobs, and capital, or increase productivity. Such advances can compensate for possible disadvantages in the cost of capital and labor faced by firms by enhancing the quality or efficiency in the production of existing goods and services. Scientific advances, government activity, the organization and management of firms, and serendipity can all influence technological progress regardless of economic conditions. In addressing U.S. competitiveness, two policy approaches have primarily been used. One relies on direct measures that include budget outlays and the provision of services by government agencies. The other uses indirect measures such as financial incentives and legal changes.[3]

[2] For more information on ARPA-E, see CRS Report RL34497, *Advanced Research Projects Agency - Energy (ARPA-E): Background, Status, and Selected Issues for Congress*, by Deborah D. Stine.

[3] Excerpt from CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over* (continued...)

Since World War II, the United States has used a combination of direct and indirect approaches to enhance current and future U.S. competitiveness.[4] Following World War II, the Steelman report was issued expressing concerns about U.S. competitiveness: "the future is certain to confront us with competition from other national economies of a sort we have not hitherto had to meet."[5]

Interest in the competitiveness issue perhaps reached its peak in the 1970s, when some experts became concerned that Japan, Europe, and newly industrialized countries were becoming major competitors with the United States. The United States had lost market share in autos, cameras, stereos, television sets, steel, machine tools, and microelectronics. Some also expressed concerns that U.S. technological superiority, as exhibited by the balance of trade in high-technology products, was declining as the U.S. share of world exports on research and development (R&D)-intensive goods fell while the Japanese share rose. Other indicators were lower productivity growth in the United States than Japan, a narrowing in the gap of the production in the number of scientists and engineers graduating from U.S. universities and those engaged in R&D in the United States compared to Japan and West Germany, the relative proficiency of U.S. high school students in science and mathematics, and a decline in the number of patents granted to Americans while those to foreign inventors doubled. The cause, some believed, was due to U.S. expenditures for civilian R&D falling behind that of Europe and Japan, or some European countries and Japan deriving more economic benefit from their R&D expenditures.[6]

Congress responded by taking a number of actions including passing the Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480), the Patent and Trademark Act Amendments of 1980 (known as the Bayh-Dole Act, P.L. 96-517), the Federal Technology Transfer Act (P.L. 99-502), the National Cooperative Research Act (P.L. 98-462), and the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418). In addition, the Semiconductor Manufacturing Technology, or SEMATECH, consortium, an on-site test facility and a conduit for new technological advances for the U.S. semiconductor industry, was created.[7]

Additional congressional actions also focused on increasing corporate spending on research and development in response to competitiveness concerns included the 1981 Economic Recovery Tax Act (P.L. 97-34) and the Tax Reform Act of 1986 (P.L. 99-514), which provided for a research

(...continued)

Government Policy, by Wendy H. Schacht.

[4] Bruce L. R. Smith, *American Science Policy Since World War II* (Washington, DC: Brookings Press, 2000). Kent H. Hughes, *Building the Next American Century: The Past and Present of American Economic Competitiveness* (Baltimore: The Johns Hopkins Press, 2005). James Turner, "The Next Innovation Revolution: Laying the Groundwork for the United States," *innovations*, spring 2006, p. 123-144, at http://publicaa.ansi.org/sites/apdl/Documents/News%20and%20Publications/Other%20Documents/Turner-Innovations.pdf.

[5] John R. Steelman, *Science and Public Policy* (Washington, DC: Government Printing Office, August 1947). Reprinted by the Arno Press, New York, NY, 1980.

[6] Bruce L. R. Smith, *American Science Policy Since World War II* (Washington, DC: Brookings Press, 2000), p. 101-105.

[7] CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, CRS Report RL30320, *Patent Ownership and Federal Research and Development (R&D): A Discussion on the Bayh-Dole Act and the Stevenson-Wydler Act*, CRS Report RL33526, *Cooperative R&D: Federal Efforts to Promote Industrial Competitiveness*, all by Wendy H. Schacht. CRS Issue Brief IB93024, *SEMATECH: Issues and Options*, by Glenn J. McLoughlin.

and experimentation (R&E) tax credit. The Small Business Development Act (P.L. 97-219; P.L. 99-443) established a set-aside of federal R&D funds to support work in innovative small firms. [8]

The competitiveness concerns continued until the mid-1990s when the United States economy and technological innovation improved. Actions were taken by U.S. manufacturers to improve their quality and efficiency, universities and national laboratories increased their linkages to U.S. companies, and the United States was successful in many innovation-based industries such as Internet applications, biotechnology, and nanotechnology while the Japanese economy was in a decline.[9]

Now that the nation has entered the 21st century, today's competitiveness concerns tend to be focused on issues related to globalization—that is, a global economy—along with some of the same concerns discussed in previous competitiveness debates—these include whether or not federal science and engineering research funding is sufficient, questions about STEM education quality, and the number of Americans obtaining science and engineering degrees. Much of what Americans consume or buy is produced in other countries, and much of what Americans produce is exported abroad. For example, a growing number of the largest U.S. companies rely on international markets for over 50% of their sales and employ more foreign workers than domestic. This globalization has a growing impact, both positive and negative, on the economic futures of American companies, workers, and families. Increasing integration with the world economy can make the United States more productive, leading to increases in living standards and real disposable incomes. However, rising trade with low-wage developing countries increases workers' concerns about job loss, lower wages, and benefits as American companies take actions to compete in a global economy. The information technology revolution has expanded these competitiveness concerns to U.S. white collar jobs.[10]

Three broad trends influence today's globalization of the economy. The first is technology, which has sharply reduced the cost of communication and transportation that previously divided markets. The second is a dramatic increase in the world supply of labor producing goods and services traded internationally. The third is government policies that have reduced barriers to trade and investment.[11]

The America COMPETES Act includes policies that address each of these trends. The act addresses these issues by authorizing primarily direct measures in each of these policy areas. In addition, the act authorizes two committees—one inside government and the other outside government—to look at indirect policy mechanisms.

With respect to technology, some believe that today's federal funding of basic science and engineering research is inadequate to generate the technological progress needed to create new industries and the associated jobs. The act responds to that concern by increasing federal funding of basic research at the federal agencies primarily responsible for funding physical sciences,

[8] CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy H. Schacht.

[9] George R. Heaton, Jr., Christopher T. Hill, Patrick Windham, David W. Cheney, "Innovation Policy Today in the United States: The Mainstream Consensus and Other Views," Technology Policy International, May 2007, at http://www.technopoli.net/InnovationPolicy2007.pdf.

[10] Excerpt from CRS Report RL34091, *Globalization, Worker Insecurity, and Policy Approaches*, by Raymond J. Ahearn.

[11] Ibid.

engineering, mathematics, and computer science—fields that are considered to be major contributors to competitiveness due to their potential for innovation and job creation. In addition, the America COMPETES Act renames and refocuses an existing program that helps fund high-risk research and development at small and medium-sized businesses.

With respect to labor, the act takes actions that are intended to make the U.S. labor pool more competitive with the world supply of labor. Currently, some believe that inadequate numbers of American students are proficient in science and mathematics. In addition, the number of Americans pursuing post-secondary STEM degrees is considered to be low relative to students in countries considered to be U.S. competitors.[12] The act responds to these concerns by initiating a number of actions to increase the quality and quantity of STEM teachers as well as mechanisms to encourage more American students to undertake advanced STEM classes and post-secondary STEM degrees.

With respect to government trade and investment policies, the act authorizes meetings, studies, and committees to identify possible actions the United States might undertake. This includes, for example, studying and reviewing the costs faced by U.S. businesses engaged in innovation compared with foreign competitors.

Beyond the America COMPETES Act, other recent legislative initiatives propose federal efforts that

- encourage industry to spend more on research and development,
- promote joint research activities between companies,
- foster cooperative work between industry and universities,
- facilitate the transfer of technology from federal laboratories to the private sector, and
- provide incentives for quality improvements.[13]

Issues for Congress

The America COMPETES Act had strong bipartisan support; however, while some experts believe that actions should be taken to make the United States more competitive, others do not.[14] Other experts believe that actions should be taken in response to competitiveness concerns, but express doubts that the actions proposed in the America COMPETES Act are the best actions to take.[15]

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[12] CRS Report 98-871, *Science, Engineering, and Mathematics Education: Status and Issues*, by Christine M. Matthews. CRS Report RL33434, *Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action*, by Jeffrey J. Kuenzi.

[13] For more details, see CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy H. Schacht.

[14] See for example, Robert J. Samuelson, "A Phony Science Gap?," *Washington Post*, February 22, 2006, at http://www.washingtonpost.com/wp-dyn/content/article/2006/02/21/AR2006022101166.html; Sebastian Mallaby, "The Fake Science Threat," *Washington Post*, February 6, 2006, at http://www.washingtonpost.com/wp-dyn/content/article/2006/02/05/AR2006020501059.html.

[15] See, for example, David Goldston, "Making room for dissent," *Nature*, 448:524, August 2, 2007, at
(continued...)

Perspectives on the Definition of Competitiveness

The definition of a nation's competitiveness, and the public's response to particular policies, can vary depending on whether it is from the perspective of an individual domestic firm, a multinational corporation, or domestic labor. For an individual domestic firm, the focus of competitiveness is trade and the firm's ability to compete for market share against imports from abroad or to compete with foreign firms in overseas export markets. From this perspective, a key measure of competitiveness is the economy's trade balance.[16]

Trade Balance

Table 1 shows U.S. trade in advanced technology products. This includes about 500 commodity classification codes representing products whose technology is from a recognized high technology field (e.g., biotechnology) or that represent the leading technology in a field. The United States long ran a surplus in these products, but that surplus dropped sharply in 2000 and turned into a deficit in 2002. The U.S. trade balance in high technology products was last in surplus in 2001.[17]

In 2002 to 2005, the United States ran a trade deficit in high technology products which grew roughly ten billion dollars per year, from $16.6 billion to $43.6 billion. In 2006 this deficit dropped to $38.1 billion, but in 2007 resumed its former path of growing ten billion dollars per year, to $52.6 billion, but in 2008, this deficit grew to only $55.5 billion. This deficit does not necessarily imply that the United States is losing the high technology race, since many of the high technology imports are from U.S. companies (particularly electronics manufacturers) who assemble the products overseas. However, this growing deficit may warrant closer policy scrutiny.[18]

Table 1. U.S. Trade in Advanced Technology Products

(billions of U.S. dollars)

Year	U.S. Exports	U.S. Imports	Trade Balance
1990	93.4	59.3	34.1
1995	138.4	124.8	13.6
1996	154.9	130.4	24.5
1997	179.5	147.3	32.2
1998	186.4	156.8	29.6
1999	200.3	181.2	19.1
2000	227.4	222.1	5.3

(...continued)

http://www.nature.com/nature/journal/v448/n7153/full/448524a.html.

[16] CRS Report RS22445, *Taxes and International Competitiveness*, by Donald J. Marples.

[17] Excerpt from CRS Report RL33577, *U.S. International Trade: Trends and Forecasts*, by Dick K. Nanto, Shayerah Ilias, and J. Michael Donnelly.

[18] Ibid.

Year	U.S. Exports	U.S. Imports	Trade Balance
2001	200.1	195.3	4.8
2002	178.6	195.2	-16.6
2003	180.2	207.0	-26.8
2004	201.4	238.3	-36.9
2005	216.1	259.7	-43.6
2006	252.7	290.8	-38.1
2007	275.8	326.8	-52.6
2008	275.8	331.4	-55.5

Source: U.S. Bureau of the Census. *U.S. International Trade in Goods and Services*. FT-900, issued monthly. Excerpt from CRS Report RL33577, *U.S. International Trade: Trends and Forecasts*, by Dick K. Nanto, Shayerah Ilias, and J. Michael Donnelly.

Notes: Includes about 500 of some 22,000 commodity classification codes that meet the following criteria: (1) contains products whose technology is from a recognized high technology field (e.g., biotechnology), (2) represent leading edge technology in that field, and (3) constitute a significant part of all items covered in the selected classification code. Data are on a BoP basis.

Foreign Direct Investment

For a U.S. multinational corporation, one based in the United States but with production facilities abroad, competitiveness is defined as the ability of its overseas operations to compete for market share with firms from foreign host countries or firms from third countries. From this perspective, a key measure of competitiveness is the degree to which these firms invest their resources in the United States or in other countries (known as "foreign direct investment").[19] As shown in **Figure 1**, foreign direct investment in the United States[20] declined sharply after 2000, when a record $300 billion was invested in U.S. businesses and real estate, but rebounded to $184 billion by 2006.[21]

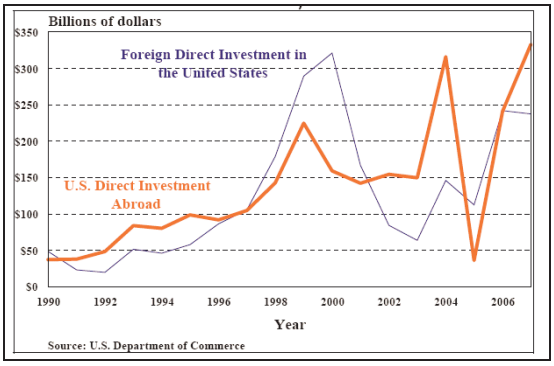
[19] Excerpt from CRS Report RS22445, *Taxes and International Competitiveness*, by Donald J. Marples.

[20] The United States defines foreign direct investment as the ownership or control, directly or indirectly, by one foreign person (individual, branch, partnership, association, government, etc.) of 10% or more of the voting securities of an incorporated U.S. business enterprise or an equivalent interest in an unincorporated U.S. business enterprise. 15 C.F.R. § 806.15 (a)(1).

[21] Excerpt from CRS Report RS21857, *Foreign Direct Investment in the United States: An Economic Analysis*, by James K. Jackson.

Domestic labor is likely to share some of the same concerns of the firms and corporations for whom they work, but is also likely to define competitiveness as the firm's ability to compete against foreign firms in export markets or in markets within the United States. Competition is viewed as being between different investment sites and the ability of the United States to compete with foreign countries as a location for what domestic labor views as a job-creating business investment. Key measures for domestic labor are the level of employment and the wages received from employment in the economy.[22]

Figure 1. Foreign Direct Investment in the United States and U.S. Direct Investment Abroad, Annual Flows, 1990-2006



Source: Excerpt from CRS Report RS21857, *Foreign Direct Investment in the United States: An Economic Analysis*, by James K. Jackson. CRS analysis from Department of Commerce data.

The United States is both the largest recipient of foreign direct investments as well as the largest investor abroad.[23] Investment by U.S. firms abroad was $249 billion in 2006 (see **Figure 1**).[24] While some view these investments as an economic gain, others express concern about displaced U.S. workers and lower wages. Seventy percent of U.S. foreign direct investment, however, is concentrated in high-income developed countries and the share of investment going to developing countries has fallen in recent years. As a result, most economists conclude that direct investment abroad is due to a broad restructuring of U.S. manufacturing industries and does not lead to fewer jobs or lower incomes overall for Americans.[25]

Workforce and Wages

NSF statistical analysts have indicated that determining the science and engineering workforce and the jobs created as a result of science and engineering is a challenging task.[26] NSF identifies five broad categories of science and engineering occupations: computer and mathematical scientists, life scientists, physical scientists, social scientists, and engineers.

This classification, however, does not account for all those with science and engineering degrees who use this knowledge in their occupations. For example, a chemist who teaches high school chemistry and an engineer who manages a manufacturing plant are classified as a teacher and a manager, respectively, and are not included in NSF's analysis of the science and engineering (S&E) workforce. In addition, there are those who are in science- and engineering-related

[22] Excerpt from CRS Report RS22445, *Taxes and International Competitiveness*, by Donald J. Marples.

[23] Excerpt from CRS Report RS21118, *U.S. Direct Investment Abroad: Trends and Current Issues*, by James K. Jackson.

[24] Excerpt from CRS Report RS21857, *Foreign Direct Investment in the United States: An Economic Analysis*, by James K. Jackson.

[25] Excerpt from CRS Report RS21118, *U.S. Direct Investment Abroad: Trends and Current Issues*, by James K. Jackson.

[26] For a fuller discussion of the science and technology workforce, see CRS Report RL34539, *The U.S. Science and Technology Workforce*, by Deborah D. Stine and Christine M. Matthews.

occupations who use science and engineering knowledge in their jobs, but who may or may not have degrees in science and engineering: for example, a patent attorney or a physician. Some also use their S&E training in nominally non-S&E occupations such as writers, salesmen, financial managers, and legal consultants. As the need for science and engineering knowledge has increased for a growing number of occupations, traditional accounting of such occupations provides less understanding of the science and engineering workforce and it could be considerably larger, perhaps two to three times, than provided in government analyses by the NSF, the Bureau of Labor Statistics (BLS), and the U.S. Census Bureau.[27]

According to the National Science Board (NSB), depending on the definition and perspective used, the size of the science and engineering workforce varied between approximately 5.0 million and 21.4 million individuals in 2006. NSB suggests that the most relevant number may be 17.0 million, which in 2006 was the number of individuals who had at least one degree in a science and engineering field, or 21.4 million, which also includes those who have degrees in an S&E related field such as health or technology. According to the NSB, these numbers reflect the many ways science and technical knowledge is used in the United States. This is quite different from that of NSF's science and engineering occupation data (5.0 million in 2006), the U.S. Census Bureau's data (3.9 million in 2005), or BLS data (5.4 million for S&E and 7.4 for STEM occupations[28] in May 2006). A third option is provided by NSF's data that is based on workers' own reporting of their need for at least a bachelor's degree level of science and engineering knowledge (12.9 million in 2003).[29]

Statistical analysts also find challenging accounting for the need of all workers to have a basic understanding of STEM and of the workers whose employment is related to new technologies. **Figure 2** provides an analysis that shows how the skills needed for employment have changed due to computerization. This computerization has reduced the need for routine manual and cognitive tasks and replaced them with high-level tasks. This analysis found that "Translating task shifts into education demand, the model can explain sixty percent of the estimated relative demand shift favoring college labor during 1970 to 1998. Task changes within nominally identical occupations account for almost half of this impact."[30]

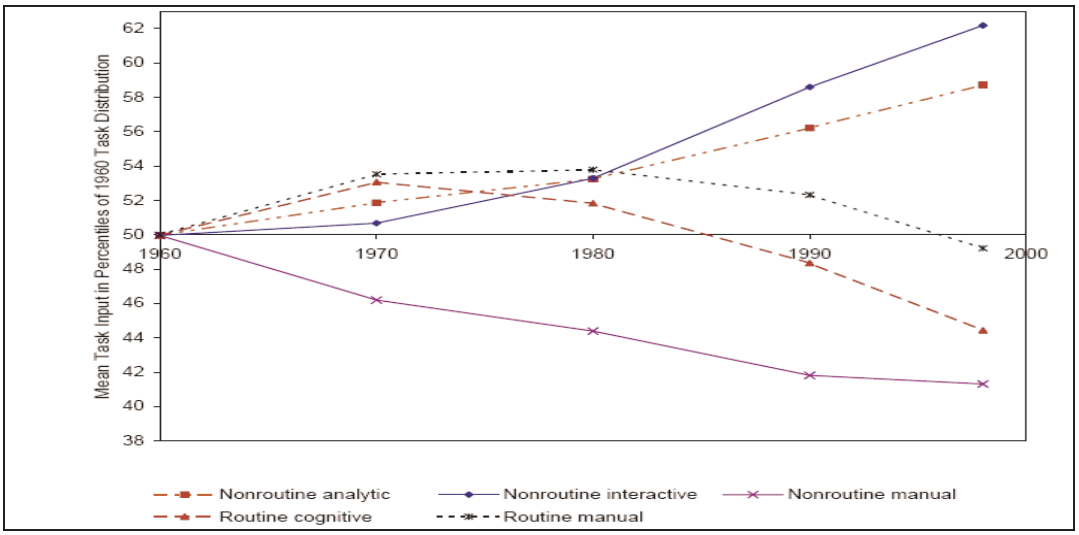
[27] National Science Foundation, "Counting the S&E Workforce—It's Not that Easy," NSF 99-344, May 3, 1999 at http://nsf.gov/statistics/issuebrf/sib99344.htm. National Science Board, Science and Engineering Indicators 2008 (Arlington, VA: National Science Foundation) Chapter 3 at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

[28] The NSB defines STEM occupations as science and engineering (S&E) occupations plus technicians, programmers, technical managers, and a small number of S&E-related occupations such as actuary and architect.

[29] National Science Board, Science and Engineering Indicators 2008 (Arlington, VA: National Science Foundation) Chapter 3 at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

[30] David H. Autor, Frank Levy, and Richard J. Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration," *Quarterly Journal of Economics*, 118(4), November 2003.

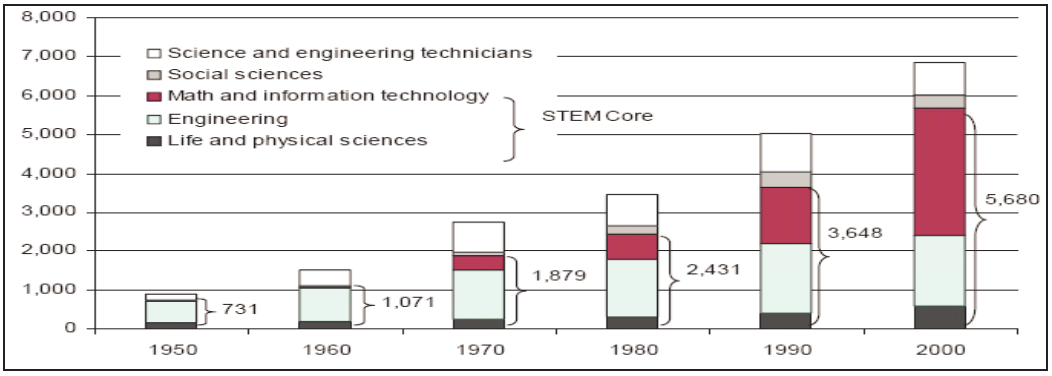
Figure 2. Trends in Routine and Nonroutine Task Input, 1960-1980



Source: David H. Autor, Frank Levy, and Richard J. Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration," *Quarterly Journal of Economics*, 118(4), November 2003.

The most long-term analysis of S&E workforce trends is that of the U.S. Census Bureau. As shown in **Figure 3**, the number of workers in science and engineering occupations grew significantly—7.7 times larger in 2000 than in 1950. This growth rate is higher than that of the total labor force, which grew 2.3 times, and that of all managers and professionals, which grew 4.9 times. The STEM growth rate in the 1990s was a little more than three times that of the overall labor force.[31]

Figure 3. Science, Technology, Engineering, and Mathematics Workforce, 1950-2000 (in thousands)



Source: B. Lindsay Lowell and Mark Regets, "A Half-Century Snapshot of the STEM Workforce, 1950-2000," Commission on Professionals in Science and Technology, August 2006 at https://www.cpst.org/STEM/STEM_White1.pdf.

Notes: Derived from U.S. Census microdata. STEM Core = engineering, life and physical scientists, and math and information technology.

[31] B. Lindsay Lowell and Mark Regets, "A Half-Century Snapshot of the STEM Workforce, 1950-2000," Commission on Professionals in Science and Technology, August 2006, at https://www.cpst.org/STEM/STEM_White1.pdf.

More recent data of STEM workforce trends from BLS shows mixed results. These data show a decline in STEM professionals as a percentage of the employed civilian workforce beginning in 2000.[32] On the other hand, BLS reports that science and engineering occupations are projected to grow by 21.4% from 2004 to 2014, compared to a growth of 13% in all occupations during the same time period.[33] It is anticipated that approximately 65% of the growth in science and engineering occupations will be in the computer-related occupations.[34] Faster than average growth is expected as well in the life sciences, social sciences, and the science and engineering-related occupations of post-secondary teachers, healthcare practitioners and technicians, and science managers. In addition, unemployment in S&E occupations was 1.6% in 2006. And, as discussed above, it is important to remember that these projections involve only the demand for strictly defined S&E occupations, and do not include the wider range of jobs in which S&E degree holders often use their training.[35]

Figure 4 shows that the compensation for those in most STEM occupations is above those for the entire U.S. labor force while the growth rate in compensation is about the same. For all STEM workers, compensation ranges from $53,000 to $58,000 per annum compared to $47,000 to $49,500 for people in the professions, and $31,500 to $34,500 for all workers in 2005.[36]

The mean real salary for recent S&E bachelor's degree recipients increased an average of 15% across all fields from 1993 to 2003. In 2003, median salaries for S&E bachelor's degree holders 15-19 years after receiving their degree had the highest salary, $65,000—higher than non-S&E bachelor's degree recipients whose salary at that stage of their career was $49,000.[37] There can be a great deal of variance, however, among STEM occupations, fields, and sub-fields.

[32] Richard Ellis, "Is U.S. Science and Technology Policy Adrift?," Commission on Professionals in Science and Technology, October 2007, at https://www.cpst.org/STEM/STEM8_Report.pdf.

[33] Department of Labor, Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections, BLS Releases 2004-2014 Employment Projections, December 7, 2005, http://www.bls.gov/news.release/ecopro.nr0.htm.

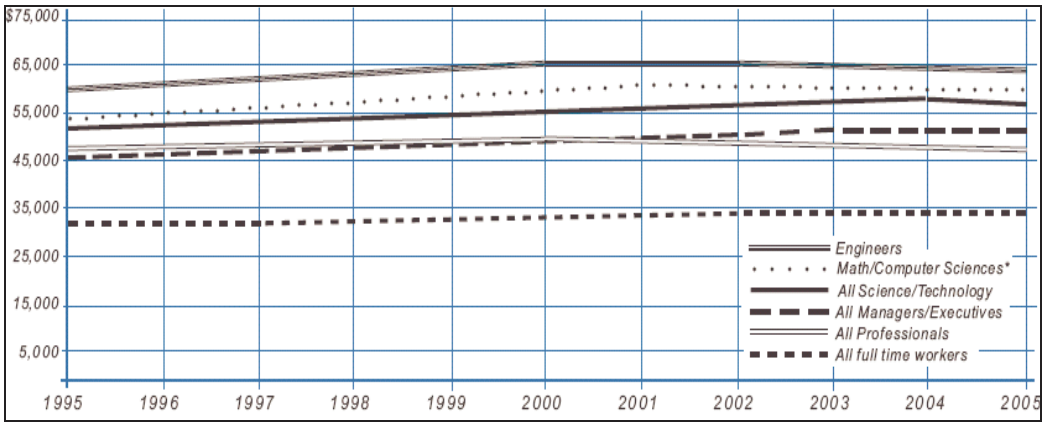
[34] Computer-related occupations include mathematical science occupations.

[35] National Science Board, Science and Engineering Indicators 2008 (Arlington, VA: National Science Foundation) Chapter 3 at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

[36] Commission on Professionals in Science and Technology, "Science and Technology Salaries: Trends and Details, 1995-2005," August 2006, at https://www.cpst.org/STEM/STEM5_Report.pdf.

[37] National Science Board, Science and Engineering Indicators 2008 (Arlington, VA: National Science Foundation) Chapter 3 at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

Figure 4. Trends in Annual U.S. Base Salaries, in Constant 2005 Dollars, 1995-2005



Source: Derived from U.S. Bureau of Labor Statistics Current Population Surveys data. Commission on Professionals in Science and Technology, "Science and Technology Salaries: Trends and Details, 1995-2005," August 2006, at https://www.cpst.org/STEM/STEM5_Report.pdf.

Competitiveness in Perspective

The Council on Competitiveness contends that these traditional measures of competitiveness—trade balance, foreign direct investment, level of employment and wages—do not fully capture a nation's competitiveness. For firms, factors such as foreign affiliate sales, intrafirm trade, fragmentation of global supply chains, and lack of inclusion of services and intangibles such as knowledge and intellectual property are not incorporated into today's assessment of the nation's competitiveness. The Council on Competitiveness also suggests that due to the global economy, assessing a nation's trade balance is not as useful a measure as it once was. Today, competition is not as much domestic companies competing with foreign companies (as captured in trade balances), but a world where "value is created through intangible assets flowing through constantly shifting global networks of multinational firms."[38] For individuals, the Council on Competitiveness suggest that factors such as pension funds, real estate, value of healthcare benefits, and purchasing power should be additional measures to understand an individual's prosperity. They also propose assessing whether or not prosperity is equivalent across all levels of society, and the potential individuals have to improve their prosperity through their own efforts.[39]

General Issues

The America COMPETES Act is based on a set of assumptions such as the following:

- STEM knowledge is necessary for all Americans, not just those entering science and engineering careers. American K-12 students do not have sufficient proficiency in STEM due to a lack of teachers with education or training in STEM. Scientists, engineers, and teachers with STEM degrees or enhanced STEM knowledge will generate more enthusiasm for STEM in students than

[38] Council on Competitiveness, *Competitiveness Index: Where America Stands* (Washington, DC: Council on Competitiveness, November 2006), p. 23.

[39] Ibid.

those without such degrees; more enthusiastic students will lead to a better-trained and more competitive workforce.

- An insufficient number of Americans obtain degrees in science, technology, engineering, and mathematics compared to the nation's economic competitors. More Americans need to be encouraged to pursue such fields so that the United States has the workforce necessary to generate the new ideas that led to the new industries. Individuals who obtain STEM degrees are smart people who can work in a variety of occupations beyond those traditionally assumed for those who earn such degrees.
- Science and engineering research is important to U.S. competitiveness because of its influence on U.S. economic growth. Current science and engineering basic research funding, particularly in the physical sciences, engineering, mathematics, and computer science, is insufficient compared to other countries with whom the United States competes. Additional federal funding of basic science and engineering research will make the nation more competitive by creating whole new industries, and the related jobs, and enhancing existing ones.

These assumptions are based on a variety of analyses. For example, in K-12 STEM education,[40] the Organization for Economic Cooperation and Development's (OECD) Program for International Student Assessment (PISA) compared the scores of U.S. 15-year-old students in science and mathematics literacy to the scores of their peers internationally in 2006. American students scored an average of 489 points on science literacy, lower than the OECD average of 500 points, and 474 points in mathematics literacy, lower than the OECD average score of 498.[41] Further, another study found that middle school mathematics teachers in the United States are not as well prepared to teach mathematics as many of their counterparts in five other countries, and this inadequate teacher preparation joins deficiencies in mathematics curriculum as reasons contributing to lower scores for American middle-schoolers.[42]

The United States has one of the lowest rates of first university degrees[43] awarded in STEM fields to that in non-STEM degree production in the world according to NSF data. In 2002, STEM degrees accounted for 16.8% of all first university degrees awarded in the United States compared to an international average of 26.4%.[44]

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[40] See also CRS Report 98-871, *Science, Engineering, and Mathematics Education: Status and Issues*, by Christine M. Matthews, and CRS Report RL33434, *Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action*, by Jeffrey J. Kuenzi.

[41] U.S. Department of Education, National Center for Education Statistics, "Highlights From PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context," NCES Report Number 2008-016, December 2007 at http://nces.ed.gov/pubs2008/2008016.pdf.

[42] William Schmidt, et al., "The Preparation Gap: Teacher Education for Middle School Mathematics in Six Countries," Mathematics Teaching in the 21st Century (MT21) project, conducted by Michigan State University for the National Science Foundation, 2007, at http://usteds.msu.edu/MT21Report.pdf. National Science Foundation, "U.S. Middle School Math Teachers Are Ill-prepared Among International Counterparts," press release 07-185, December 11, 2007, at http://www.nsf.gov/news/news_summ.jsp?cntn_id=110845.

[43] First university degrees are those designated Level 5A by the International Standard Classification of Education (ISCED 97), and usually require less than five years to complete. More information on this classification and the ISCED is available at http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm.

[44] CRS Report RL33434, *Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action*, by Jeffrey J. Kuenzi.

In science and engineering research, the U.S. Bureau of Economic Analysis, with support from the National Science Foundation, has developed a research and development satellite account to estimate the effect of investment in research and development on U.S. economic growth. By this analysis, if R&D were treated as investment, it would have accounted for 5% of real gross domestic product (GDP) growth between 1959 and 2004, and 7% between 1995 and 2004.[45]

These are illustrations of the many analyses available that emphasize such themes. Some, however, question these fundamental assumptions. They question, for example, if the United States invests in federal research programs, to what extent can the U.S. exclusively benefit from those investments? Since research is international, could not any country benefit from these investments? At what point is the nation's research investment sufficient to reach its goals? In STEM education, is this not a state and local issue? Can the federal government really have any major influence in this policy area? Will STEM education investments take too long to reach fruition relative to other investments? Will federal investments in research and STEM education provide jobs for all Americans as opposed to just scientists and engineers? Others question whether or not the actions in the act are by themselves sufficient to enhance U.S. competitiveness as many other factors beyond STEM research and education contribute to U.S. competitiveness.[46]

Further, some question the fundamental premise that any action is necessary at all regarding U.S. competitiveness. They question whether or not science and engineering research and STEM education are problems at all.[47] These analysts express doubts as to whether additional scientists and engineers in the United States are needed given current workforce projections, and why if the demand is so high, salaries for those in STEM occupations are not higher.[48] Other analysts indicate that the quality and number of scientists and engineers in China and India are exaggerated.[49]

Another set of issues focuses on the possible unintended side-effects of implementation. For example, will the act result in an oversupply of scientists and engineers?[50] Can the doubling of funding for some research programs be properly managed? Will the agencies who receive these funds face the same challenges as NIH faces today once the funding declines?[51]

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[45] Bureau of Economic Analysis/National Science Foundation, "2007 Research and Development Satellite Account," September 28, 2007 at http://www.bea.gov/newsreleases/general/rd/2007/pdf/rdreport07.pdf.

[46] George R. Heaton, Jr., Christopher T. Hill, Patrick Windham, David W. Cheney, "Innovation Policy Today in the United States: The Mainstream Consensus and Other Views," Technology Policy International, May 2007, at http://www.technopoli.net/InnovationPolicy2007.pdf.

[47] See, for example, testimony at U.S. Congress, House Committee on Science and Technology, *The Globalization of R&D and Innovation, Pt. IV: Implications for the Science and Engineering Workforce*, hearing, 110th Congress, 1st sess., November 6, 2007 at http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2032.

[48] B. Lindsay Lowell and Hal Salzman, "Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand" (Washington, D.C.: The Urban Institute, October 2007).

[49] J. Bhagwati, The World is Not Flat, *Wall Street Journal*, August 4, 2005. Vivek Wadhwa, Gary Gereffi, Ben Rissing, Ryan Ong, "Seeing through Preconceptions: A Deeper Look at China and India," *Issues in Science and Technology*, Spring 2007 at http://www.issues.org/23.3/wadhwa.html.

[50] Michael Teitelbaum, "Do We Need More Scientists," *Public Interest*, Fall 2003, pp. 40-53 at http://www.sloan.org/programs/documents/PublicInterestTeitelbaum2003.pdf.

[51] Elias A. Zerhouni, "Enhanced: NIH in the Post-Doubling Era: Realities and Strategies," *Science*, (314:5802), pp. 1088-1090, November 17 2006, at http://www.sciencemag.org/cgi/content/full/31/5802/1088?ijkey=R/B99JFPZAJgA&keytype=ref&siteid=sci.

Assuming that policymakers' concerns about U.S. competitiveness are sufficient for a response, both direct (such as increased funding) and indirect measures (such as tax policy) are proposed by proponents. The act focuses on direct measures while studying possible indirect measures that can be taken. When looking at technology development, those favoring direct government assistance contend that the government's scarce resources should focus on technologies that have the greatest promise, as determined by industry and indicated by industry's willingness to match funds. Those favoring indirect measures contend that the market is superior to government in deciding which technologies are worthy of investment, and worry about potential political interests' influences on an agency's decision to assist one technology in preference to another. Indirect policy mechanism proponents instead support policies that enhance the market's opportunities and abilities to make such choices. Those who prefer direct measures contend that indirect measures are wasteful, ineffective, and can compromise other public policy goals.[52]

American Competitiveness Initiative

President Bush announced the American Competitiveness Initiative[53] in January 2006 during his State of the Union address. The America COMPETES Act and the ACI responded to the same concern—that the United States may not be able to compete economically with other nations in the future due to insufficient investment today in science and technology research and workforce development. Many, but not all, of the provisions of ACI were part of the America COMPETES Act. Provisions of ACI found in the America COMPETES Act included increased research funding at the NSF, NIST laboratories, and the DOE Office of Science. Two STEM Education programs, Math Now and the AP/IB program, were also in both ACI and the America COMPETES Act.

Science and Engineering Research

The America COMPETES Act authorizes increases in funding for the NSF, NIST laboratories, and the DOE Office of Science, as well as two new research organizations: the Advanced Research Projects Agency-Energy (ARPA-E) and the Discovery Science and Engineering Innovation Institutes.

In addition, the act expresses a sense of the Congress that each executive agency that funds research is requested to set a goal of allocating an "appropriate" percentage of its annual basic research budget to fund high-risk, high-reward basic research projects. The act also expresses the sense of the Congress that appropriately funding NASA at the authorized levels contained in the NASA Authorization Act of 2005 (P.L. 109-155) would allow it to contribute significantly to U.S. innovation and competitiveness.

[52] CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy H. Schacht.

[53] U.S. President (G.W. Bush), *American Competitiveness Initiative*, Domestic Policy Council/Office of Science and Technology Policy, February 2006, p. 19, at http://www.ostp.gov/pdf/acibooklet.pdf.

Research Funding

The America COMPETES Act authorizes increases in funding for the NSF, NIST laboratories,[54] and the DOE Office of Science over FY2008-2010. If maintained beyond 2010, the increases would double funding for these agencies over seven years.[55]

Many organizations have advocated increasing research funding for the physical sciences, engineering, mathematics, and computer science. The specific rate of increase in the America COMPETES Act is based on the National Academies[56] *Rising Above the Gathering Storm* report,[57] which called for the federal government to increase its investment in long-term basic research by 10% annually over the next seven years. The National Academies committee that developed the report concluded that this rate of change was necessary, particularly in the physical sciences, engineering, mathematics, and information sciences, because federal funding in these fields has remained relatively flat for 15 years. According to the National Academies, agencies are less likely to support high-potential high-risk research when funding is stagnant. In addition, this type of research tends to be overlooked when there are inadequate funds to support all proposals that independent external reviewers rate as very good or excellent. Corporations are unlikely to fill this need, according to the National Academies; they fund little basic research, as it typically offers greater benefits to society than its sponsor, and is riskier than shareholders are willing to tolerate.[58]

The National Academies committee reviewed proposals from a wide variety of organizations before determining that a 10% annual increase over a seven-year period would be most appropriate. In particular, the NSF Authorization Act of 2002 (P.L. 107-368) authorized doubling NSF's research budget over five years. The committee took this into account and expanded it to other federal agencies. In sum, "The committee believes that this rate of growth strikes an appropriate balance between the urgency of the issue being addressed and the ability of the research community to apply new funds efficiently."[59]

The Administration has not indicated why it selected a 7% annual rate, that would provide a doubling-path for these research activities over 10 years, as an appropriate rate of increase for

[54] NIST is a non-regulatory federal agency within the U.S. Department of Commerce, whose mission is to "promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life." NIST laboratories conduct "research that advances the nation's technology infrastructure and is needed by U.S. industry to continually improve products and services." See http://www.nist.gov/public_affairs/general2.htm for more information.

[55] For additional information, see CRS Report RL34048, *Federal Research and Development Funding: FY2008*, by John F. Sargent Jr. et al.; CRS Report 95-307, *U.S. National Science Foundation: An Overview*, by Christine M. Matthews; and CRS Report 95-30, *The National Institute of Standards and Technology: An Appropriations Overview*, by Wendy H. Schacht.

[56] The National Academies include the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine.

[57] The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007). This report is often referred to as the "Gathering Storm report" or the "Augustine report," for its chair, Norman Augustine, retired CEO and chairman of Lockheed Martin.

[58] The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007), pp. 136-138.

[59] Ibid., p. 141.

these agencies. The Administration has indicated, however, that the amount of funding available is limited:

> Wide consensus ... exists on the importance of federally funded science to our nation's long term economic competitiveness.... The National Academies' 2005 report "Rising Above the Gathering Storm…" was an important expression of this view, and echoed findings of many other reports. Notable among its recommendations was increased funding for basic research in the physical sciences, mathematics, and engineering—areas that had stagnated while the budget for biomedical research soared. The report even recommended that investment in these areas should increase "ideally through reallocation of existing funds, but if necessary via new funds." That statement is a rare recognition of the fact that federal funds for science are limited and that some programs may have to be held constant or reduced to fund priorities. The Administration's response to this consensus was the American Competitiveness Initiative, which among other things proposed doubling budgets for NSF, NIST and the Department of Energy's Office of Science over ten years.[60]

NASA Funding

The America COMPETES Act states that NASA should be a full participant in any interagency effort to promote innovation and economic competitiveness through near-term and long-term basic scientific and engineering research and development and in the promotion of STEM education consistent with NASA's mission. The act also expresses the sense of the Congress that "robust" funding of NASA, at the levels authorized in the National Aeronautics and Space Act of 2005 (P.L. 109-155) and subsequent years, would allow NASA to contribute significantly to U.S. innovation and competitiveness, enable a fair balance of funding among its science, aeronautics, education, exploration, and human space flight programs, and allow full participation in any interagency efforts to promote innovation and economic competitiveness.[61]

The Senate and House appropriations committees have expressed concern that the President's FY2008 budget is not appropriately balanced and that insufficient funds are requested for both the President's Vision for Space Exploration and the other important initiatives at NASA.[62]

Similarly, a National Research Council report indicated that "NASA is being asked to accomplish too much with too little."[63] The report recommended that "both the executive and the legislative branches of the federal government need to seriously examine the mismatch between the tasks assigned to NASA and the resources that the agency has been provided to accomplish them and

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[60] John Marburger, Director, White House Office of Science and Technology Policy, "2007 AAAS Policy Forum," Speech at the 2007 American Association for the Advancement of Science Policy Forum, May 2007, at http://www.ostp.gov/pdf/jhm_2007_aaas_policy_forum_final.pdf.

[61] America COMPETES Act, P.L. 110-69, Section 2001. For more discussion regarding NASA and its priorities, see CRS Report RL34623, *Housing and Economic Recovery Act of 2008*, coordinated by N. Eric Weiss, and CRS Report RS22625, *National Aeronautics and Space Administration: Overview, FY2008 Budget in Brief, and Key Issues for Congress*, by Daniel Morgan and Carl E. Behrens.

[62] U.S. Congress, House Committee on Appropriations, report to accompany H.R. 3093, 110th Cong., 1st sess., July 25, 2007, H.Rept. 110-24, part 1 (Washington: GPO, 2007) p. 109; U.S. Congress, Senate Committee on Appropriations, report to accompany S. 1745, 110th Cong., 1st sess., June 29, 2007, S.Rept. 110-24, part 1 (Washington: GPO, 2007), p. 101; National Research Council, Space Studies Board, *An Assessment of Balance in NASA's Science Program*, Washington, DC, 2006, p. 2 http://www.nap.edu/catalog.php?record_id=11644.

[63] National Research Council, Space Studies Board, *An Assessment of Balance in NASA's Science Program*, Washington, DC, 2006, p. 2 http://www.nap.edu/catalog.php?record_id=11644.

should identify actions that will make the agency's portfolio of responsibilities sustainable." Others also question if NASA has the right priorities.[64]

High-Risk, High-Reward Research

The America COMPETES Act also expresses the sense of the Congress that each executive research agency should set a goal of allocating an appropriate percentage of its basic research funding for high-risk, high reward ("transformative") projects. Such transformative research, the act states, should meet fundamental technological or scientific challenges, and involve multidisciplinary work and a high degree of novelty.[65]

The America COMPETES Act high-risk research provision responds to some researchers' concerns that current federal research funding review mechanisms are not as open as they could be to new, unproven ideas.[66] The National Science Board (NSB) found that

> Transformative research frequently does not fit comfortably within the scope of project-focused, innovative, step-by-step research or even major centers, nor does it tend to fare well wherever a review system is dominated by experts highly invested in current paradigms or during times of especially limited budgets that promote aversion to risk.[67]

Further, "investigators are reluctant to submit radical or paradigm-challenging research ideas to NSF given the low conventional success rate (over $2 billion of highly rated proposals were declined in FY2004)."[68] The National Institutes of Health also has indicated that this issue is a concern and, in response, has developed the Pioneer's Award to foster high-risk research.[69]

The Consolidated Appropriations Act, 2008 (P.L. 110-161) explanatory language states the following regarding transformative research at NSF:

> Transformative research is considered to be both revolutionary and "cutting edge." While the Foundation currently conducts research that could be considered transformational, several reports including the National Science Board's (NSB) Enhancing Support of Transformative Research at the National Science Foundation notes that no funds are dedicated for this express purpose. The Appropriations Committees direct the Foundation to review current practices supporting the solicitation of, and the support of, transformational proposals. The Foundation shall provide a report regarding this review to the Committees on how this emerging area can be addressed, 90 days after enactment of this Act, and provide semi-

[64] See, for example, Gregg Easterbrook, "How NASA Screwed Up (And Four Ways to Fix It)," *Wired*, May 22, 2007, at http://www.wired.com/science/space/magazine/15-06/ff_space_nasa; *The Economist*, "Spacemen Are from Mars," September 27, 2007, at http://www.economist.com/opinion/displaystory.cfm?story_id=9867224.

[65] America COMPETES Act, Section 1008, "Sense of Congress on Innovation Acceleration Research."

[66] The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007), p. 149; Jeff Mervis, "Risky Business: Can the U.S. Government Do a Better Job of Betting on Long Shots in Science? NSF and NIH Hope the Answer Is Yes," *Science*, October 8, 2004.

[67] National Science Board, *Enhancing Support for Transformational Research at the National Science Foundation*, 2007, at http://nsf.gov/nsb/documents/2007/tr_report.pdf.

[68] National Science Board, *Report of the National Science Board on the National Science Foundation's Merit Review System*, 2005, at http://www.nsf.gov/nsb/documents/2005/0930/merit_review.pdf.

[69] National Institutes of Health, "NIH Roadmap for Medical Research, High-Risk Research," webpage, at http://nihroadmap.nih.gov/highrisk/.

> annual reports with any updates thereafter. The initial report should include the Foundation's definition of transformative research.

The House Committee on Appropriations also indicated that $10 million of NSF's budget should be for a "new and dedicated program emphasizing transformative research."[70]

Advanced Research Projects Agency-Energy

The America COMPETES Act authorizes ARPA-E.[71] If funded, ARPA-E would be a new federal organization in DOE. As outlined in the America COMPETES Act, the goal of ARPA-E is to enhance the economic and energy security of the United States through the development of technologies that reduce foreign energy imports, reduce energy-related greenhouse gas emissions, improve energy efficiency in all economic sectors, and ensure the United States is a technical leader in developing and deploying advanced energy technologies.

ARPA-E is intended to achieve this goal through energy technology projects by identifying and promoting revolutionary advances in fundamental sciences, translating scientific discoveries and cutting-edge inventions into technological innovations, and accelerating transformational technological advances in areas that industry, by itself, is not likely to undertake because of technical and financial uncertainty.

ARPA-E is based on the DARPA research management model used by the Department of Defense. Currently, DARPA seeks to sponsor revolutionary, high-payoff research that "bridges the gap between fundamental discoveries and their military use."[72] Although the concept for ARPA-E in the act was based on that in the National Academies report *Rising Above the Gathering Storm*,[73] proposing the DARPA model for other parts of the U.S. federal research system has been explored before. Historically, a number of similar initiatives have been proposed. For example, a number of initiatives including an advanced civilian technology agency were proposed in the 100th and 101st Congresses.[74] In 1992, a National Academy of Sciences report recommended that the government consider a civilian technology corporation or a civilian technology agency, in limited areas, including energy research.[75] A similar action was proposed by the Progressive Policy Institute in 1993.[76] At the time presidential candidate Bill Clinton and

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[70] U.S. Congress, House Committee on Appropriations, report to accompany H.R. 3093, 110th Cong., 1st sess., July 25, 2007, H.Rept. 110-24, part 1 (Washington: GPO, 2007), p. 124.

[71] For more information on ARPA-E, see CRS Report RL34497, *Advanced Research Projects Agency - Energy (ARPA-E): Background, Status, and Selected Issues for Congress*, by Deborah D. Stine.

[72] Testimony of Dr. Tony Tether, Director, Defense Advanced Research Projects Agency, in U.S. Congress, House Committee on Science, *The Future of Computer Science Research in the United States*, hearing, 109th Cong., 1st sess., May 12, 2005, H.Hrg. 109-14 (Washington, GPO, 2005) at http://science.house.gov/commdocs/hearings/full05/may12/tether.pdf.

[73] The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007), p. 154.

[74] During the 101st Congress, 2nd session, these included S. 1978, H.R. 3833, H.R. 4715, S. 2765. U.S. Congress, Office of Technology Assessment, *Making Things Better: Competing in Manufacturing*, OTA-ITE-443 (Washington, DC: U.S. Government Printing Office), February 1990.

[75] National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *The Government Role in Civilian Technology: Building a New Alliance* (Washington, DC: National Academy Press, 1992).

[76] Will Marshall and Martin Schram, *Mandate for Change* (New York: Berkeley Books, 1993).

Senator Al Gore proposed the creation of a civilian advanced research agency to support research on renewable technologies and renewable fuels.[77]

In congressional testimony, members of the committee that wrote the National Academies report, including Secretary of Energy Steven Chu, indicated ARPA-E should have four objectives:

> 1. Bring a freshness, excitement, and sense of mission to energy research that will attract many of our best and brightest minds—those of experienced scientists and engineers, and, especially, those of students and young researchers, including those in the entrepreneurial world.
>
> 2. Focus on creative, out-of-the-box, potentially transformational research that industry cannot or will not support.
>
> 3. Utilize an ARPA-like organization that is flat, nimble, and sparse, yet capable of setting goals and making decisions that will allow it to sustain for long periods of time those projects whose promise is real, and to phase out programs that do not prove to be productive or as promising as anticipated.
>
> 4. Create a new tool to bridge the troubling gaps between basic energy research, development, and industrial innovation. It can serve as a model for how to improve science and technology transfer in other areas that are essential to our future prosperity.[78]

The report proposed that funding for ARPA-E start at $300 million the first year and increase to $1 billion per year over five to six years. At that point, the program's effectiveness would be evaluated and appropriate actions taken. Regarding the funding of ARPA-E, National Academies committee members testified that it was critical that ARPA-E funding not jeopardize the basic research supported by the DOE's Office of Science.

The National Academies committee did not believe it appropriate to specify the organization and mission of ARPA-E in great detail, but rather that those details should be "worked out by the Secretary of Energy and the Under Secretary for Science in rapid, but intense, consultation with experts from the scientific and engineering communities."[79]

For more information on ARPA-E, see CRS Report RL34497, *Advanced Research Projects Agency - Energy (ARPA-E): Background, Status, and Selected Issues for Congress*, by Deborah D. Stine.

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[77] Bill Clinton and Al Gore, *Putting People First: How We Can All Change America* (New York: Random House, 1992).

[78] Testimony of Dr. Charles M. Vest, in U.S. Congress, Senate Committee on Energy and Natural Resources, *Protecting America's Competitive Edge—Energy*, hearings, 109th Congress, 2nd sess., February 14, 2006, S.Hrg. 109-358 (Washington: GPO, 2006) at http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=1526&Witness_ID=4320. Testimony of Dr. Steven Chu, in U.S. Congress, House Committee on Science, *Should Congress Establish "ARPA-E", The Advanced Research Projects Agency - Energy?*, hearings, 109th Congress, 2nd sess., March 9, 2006, H.Hrg. 109-39 (Washington: GPO, 2006).

[79] Ibid.

Discovery Science and Engineering Innovation Institutes

The America COMPETES Act directs DOE to establish multidisciplinary Discovery Science and Engineering Innovation Institutes at DOE National Laboratories to apply fundamental science and engineering discoveries to technological innovations. The institutes, along with their higher-education and private industry partners, would support science and engineering research on emerging technologies determined by the Secretary of Energy to be critical to global competitiveness. In addition, the Institutes are intended to train undergraduate and graduate science and engineering students, develop innovative undergraduate and graduate educational curricula, conduct research with higher-education partners, and develop innovative technologies with industrial partners.[80]

Those supporting the institutes believe it will provide an opportunity for DOE National Laboratories to work with universities to train engineers in such areas as nanoscience and microsystems.[81] The training of those engineers and the tasks they perform, proponents indicate, require a reshaping of the nation's engineering research, education, and practices to respond to challenges in global markets, national security, energy sustainability, and public health. They contend that the changes are not only technological, but also cultural, and they will affect the structure of organizations and relationships between institutional sectors of the country. This task, proponents indicate, cannot be accomplished by any one sector of society but must involve the federal government, states, industry, foundations, and academia.[82]

Science, Technology, Engineering, and Mathematics (STEM) Education

The America COMPETES Act authorizes many new STEM education programs focused on recruiting more STEM teachers and enhancing the knowledge and skills of current STEM teachers. The act also encourages and supports students at all levels to undertake STEM education through a variety of initiatives that include not only traditional education, but also summer institutes and research internships at national labs. Many of the programs in the act place an emphasis on outreach and mentoring for women and minorities and inclusion of students and teachers from high-need schools.[83]

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[80] A similar concept, Discovery-Innovation Institutes proposed in a National Academy of Engineering report, was the starting point for the Discovery Science and Engineering Innovation Institutes concept. The purpose of the institutes, located on the campuses of research universities, was to "link fundamental scientific discoveries with technological innovations to create products, processes, services to meet the needs of society." The NAE committee recommended that these institutes play a role similar to that of academic medical centers and agricultural experiment stations that combine research, education, and professional practice to drive transformative change and stimulate significant regional economic activity, such as the location nearby of clusters of start-up firms, private research organizations, suppliers, and other complementary groups and businesses. National Academy of Engineering, *Engineering Research and America's Future*: *Meeting the Challenges of a Global Economy* (Washington, DC: National Academy Press, 2005), at http://books.nap.edu/catalog.php?record_id=11393.

[81] Senator Pete Domenici, *New Mexico Senators' "America COMPETES Act" Passed by Senate, 88-8*, press release, April 25, 2007.

[82] National Academy of Engineering, *Engineering Research and America's Future*: *Meeting the Challenges of a Global Economy*, p. 24 (Washington, DC: National Academy Press, 2005), at http://books.nap.edu/catalog.php?record_id=11393.

[83] The definition of "high-need" varies throughout the act. See footnotes 11 and 12 for the definition of high-need for a particular program.

The STEM education programs in the America COMPETES Act include

- a pilot program of grants to states to help establish or expand statewide specialty high schools in STEM education;
- experiential-based learning opportunities, internships for middle and high-school students[84] including hands-on learning at the DOE national labs;
- centers of excellence in STEM education in at least one high-need, public secondary school[85] in each DOE National lab region, in order to develop and disseminate best practices in STEM education;
- summer institutes at the DOE national labs and partner universities, in order to improve the STEM content knowledge of kindergarten through 12th grade teachers throughout the country;
- a newly appointed Director for STEM Education at the Department of Energy, who would also serve as an interagency liaison for K-12 STEM education;
- a graduate research fellowship program for outstanding graduate students, called Protecting America's Competitive Edge (PACE), in fields of interest to the DOE plus imagination, creativity, and excellent written and oral communication skills;
- two new competitive grant programs at the Department of Education (ED), called Teachers for a Competitive Tomorrow, that would enable partnerships to implement, in STEM fields, courses of study that lead to a baccalaureate degree with concurrent teacher certification, and at the graduate level, a two- or three-year, part-time, master's degree program for current teachers to improve their content knowledge and teaching skills in these areas as well as a one-year master's degree program for STEM professionals to enhance their teaching skills and teacher certification.
- a program called Math Now would improve instruction in mathematics by providing teachers with research-based tools and professional development to enhance elementary and middle school students' achievement in math;
- a new program called the Advanced Placement/International Baccalaureate (AP/IB) Program would expand low-income students' access to AP/IB coursework by training more high school teachers to lead AP/IB courses in math, science, and critical foreign languages in high-need[86] schools;

[84] Priority is given to students from schools in which not less than 30% of the children enrolled in the school are from low-income families, or that are designated with a school locale code of 41, 42, or 43, as determined by the Secretary of Education; and for which there is a high percentage of teachers who are not teaching in the academic subject areas or grade levels in which the teachers were trained to teach, a high teacher turnover rate, or a high percentage of teachers with emergency, provisional, or temporary certification or licenses.

[85] For this program, a "high-need public secondary school" is defined in the America COMPETES Act (42 U.S.C. 7381l) as a secondary school with "(1) with a high concentration of low-income individuals (as defined in section 1707 of the Elementary and Secondary Education Act of 1965 (20 U.S.C. 6537)); or (2) designated with a school locale code of 41, 42, or 43, as determined by the Secretary of Education."

[86] A "high-need school" is defined in the act as one with a pervasive need for Advanced Placement or International Baccalaureate courses in mathematics, science, or critical foreign languages, or for additional Advanced Placement or International Baccalaureate courses in such a subject; and with a high concentration of low-income students; or is designated with a school locale code of 41, 42, or 43, as determined by the Secretary of Education.

- increased support for a number of existing NSF programs including the

  –Robert Noyce Teacher Scholarship program, which seeks to encourage talented science, technology, engineering, and mathematics majors and professionals to become K-12 mathematics and science teachers;

  –Math and Science Partnerships program, which develops and implements ways of advancing mathematics and science education for students;

  –STEM talent expansion program (STEP), whose goal is increasing the number of students receiving associate or baccalaureate STEM degrees;

  –Advanced Technological Education (ATE) program, which promotes improvement in the education of science and engineering technicians at the undergraduate and secondary school levels;

  –Graduate Research Fellowships (GRF), which provide three years of support for graduate study in STEM fields; and

  –Integrative Graduate Education and Research Traineeship (IGERT) program, which seeks to catalyze a cultural change in graduate education by establishing innovative new models.

The issues for Congress related to these provisions are discussed below.

Department of Energy

A number of the America COMPETES Act programs are to be managed by the DOE and its National Laboratories, which have not previously played a major role in K-12 STEM education. The Administration has opposed several of the DOE-Managed STEM initiatives, including the Specialty Schools in Math and Science, Experiential-based Learning Opportunities, Summer Institutes, and the National Laboratories Centers of Excellence, indicating such programs should not be a DOE responsibility.[87] Proponents counter that the biggest challenge in K-12 STEM education is inspiring children to learn math and science, and that the best way to inspire teachers and students is by providing them with an opportunity to interact with DOE scientists and engineers actively conducting research.[88]

The DOE specialty schools for math and science are to be public secondary schools whose students reside in the state where the school is located. These schools are intended to offer students a high-quality, comprehensive STEM curriculum designed to improve the academic achievement of students in science and mathematics. The Administration contends that establishing or expanding K-12 schools should not be a DOE responsibility.[89] Supporters state that such schools will be important because states that have similar specialty schools have been a

[87] U.S. President (George W. Bush), "S. 761—America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act," Statement of Administration Policy, April 23, 2007, at http://www.whitehouse.gov/omb/legislative/sap/110-1/s761sap-s.pdf.

[88] Senator Lamar Alexander, "America's Competitiveness," remarks in the Senate, *Congressional Record*, April 24, 2007, p. S5011.

[89] U.S. President (George W. Bush), "S. 761—America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act," Statement of Administration Policy, April 23, 2007 at http://www.whitehouse.gov/omb/legislative/sap/110-1/s761sap-s.pdf.

"nucleus of excellence" in math and science, that attracts and inspires the best students and teachers.[90]

The America COMPETES Act authorizes summer internship programs at DOE national laboratories for middle and secondary school students to provide them with experiential, hands-on learning in science, technology, engineering, and mathematics. The Administration advocates that resources instead should be focused on identifying what works and improving the effectiveness of existing efforts before starting a new program for which the Administration believes that there is no clear and compelling need.[91] Proponents counter that the few weeks students spend in such programs makes a "remarkable" difference in the quality of education.[92]

DOE National Laboratory Centers of Excellence in STEM education are designed to assist teachers and allow them to use national laboratory equipment to teach courses located in at least one high-need public secondary school in the region served by a DOE national laboratory, in partnership with local higher education institution. The Administration believes that establishing school-based centers is not a proper role for DOE and would divert national laboratory resources that currently benefit their surrounding communities.[93] Proponents counter that such programs inspire teachers and students, and provide them with necessary resources.[94]

National Science Foundation

The America COMPETES Act reauthorizes a number of existing STEM education programs at the NSF and authorizes one new program. The Administration has opposed two provisions in the act: increasing funding for an existing program, the Robert Noyce Teacher Scholarship program, and establishing funding for a new program, the Laboratory Science Pilot program.

The Consolidated Appropriations Act, 2008 explanatory language states the following regarding NSF STEM education programs and the Noyce Program:

> NSF not only includes research, but also shares in the responsibility for promoting quality math and science education as intertwining objectives at all levels of education across the United States. Math and science educators play a major role in keeping the U.S. competitive in the 21st century. Increasing the number of highly qualified K-12 math and science teachers is critical to the creation of a new generation of innovators. Recommendations included in the National Academies' Rising Above the Gathering Storm report discussed the importance of expanding programs to enhance the undergraduate education of the future science and engineering workforce. Within the amounts provided, an additional $5,000,000, for a total of $15,000,000, shall be provided for the Robert Noyce Scholarship program.... The Robert

[90] Senator Lamar Alexander, "America's Competitiveness," remarks in the Senate, *Congressional Record*, April 24, 2007, p. S5011.

[91] U.S. President (George W. Bush), "S. 761—America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act," Statement of Administration Policy, April 23, 2007 at http://www.whitehouse.gov/omb/legislative/sap/110-1/s761sap-s.pdf.

[92] Senator Lamar Alexander, "America's Competitiveness," remarks in the Senate, *Congressional Record*, April 24, 2007, p. S5011.

[93] U.S. President (George W. Bush), "S. 761—America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act," Statement of Administration Policy, April 23, 2007 at http://www.whitehouse.gov/omb/legislative/sap/110-1/s761sap-s.pdf.

[94] Senator Lamar Alexander, "America's Competitiveness," remarks in the Senate, *Congressional Record*, April 24, 2007, p. S5011.

> Noyce Scholarship program encourages talented Science, Technology, Engineering, and Mathematics (STEM) undergraduate students and postgraduate professionals to become K-12 mathematics and science teachers.

The Noyce program awards grants to higher education institutions to recruit and prepare undergraduate students majoring in science, technology, engineering, and mathematics to become elementary and secondary mathematics and science teachers. Students receive scholarships and stipends in exchange for two to six years of service as a mathematics or science teacher in a high-need K-12 school district.[95] This program, and ED's Teachers for a Competitive Tomorrow (see next section), which provides funds to institutions of higher education to manage these programs, are based on the UTeach[96] and California Teach[97] programs, both considered to be successful in better preparing teachers for the classroom.[98]

The program is considered by some to be radical because academic research institutions have traditionally trained science and mathematics teachers in education departments rather than in science and mathematics departments. In addition, many of the current programs use master K-12 classroom teachers to educate students in the program and serve as role models, rather than relying solely upon the education department faculty. Further, universities involved with the program have had to change their traditional viewpoint that they are preparing students just for research careers, but also for education careers, and that these students are not "washouts," but some of their best science, engineering, and mathematics undergraduates.[99]

The act also authorizes a new program at NSF that would provide grants to institutions of higher education to create or improve professional science master's (PSM) degree programs that emphasize practical training and preparation for the workforce in high-need fields. PSM programs have been advocated for a number of years as an educational mechanism to better meet industry workforce needs. While other educational programs, such as those in engineering and business, have long viewed master's degrees as a way to serve this need, the same is not true of science programs, which have instead seen master's degrees as an interim degree on the way to a PhD. A PSM is seen by some experts as a way to achieve similar goals, by allowing "students to pursue advanced training in science or mathematics, while simultaneously developing workplace skills highly valued by employers."[100] Approximately 120 PSM programs at 60 institutions, generally developed with industry guidance, include two years of academic training in an emerging or interdisciplinary area, internships, and "cross-training" in business and communications.[101]

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[95] For more information on this program, see http://www.nsf.gov/pubs/2007/nsf07529/nsf07529.htm and National Science Foundation, *Cultivating Math and Science Teachers for High-need School Districts*, press release, at http://www.nsf.gov/news/news_summ.jsp?cntn_id=110481&org=NSF&from=news. As of October 2007, 91 awards to institutions in 32 states have been made. These institutions then provide scholarships to students. The results of an ongoing program evaluation, which will provide an analysis of the program since it originated in 2002, will be available in 2008.

[96] For more information, see http://www.uteach.utexas.edu/.

[97] For more information, see http://www.universityofcalifornia.edu/academics/1000teachers/.

[98] Rep. George Miller, "Conference Report on H.R. 2272, America COMPETES Act," remarks in the House, *Congressional Record*, August 2, 2007, p. H9592.

[99] Jeffrey Mervis, "A New Twist on Training Teachers," *Science*, June 1, 2007, 316:5829, pp. 1270-1277 at http://www.sciencemag.org/cgi/content/full/316/5829/1270.

[100] National Professional Science Masters Association, webpage, at http://www.sciencemasters.com/.

[101] Ibid.

The NSF Laboratory Science Pilot program would award grants to partnerships of higher education institutions, high-need local educational agencies, businesses, eligible nonprofit organization, and others to improve school laboratories and instrumentation as part of a comprehensive program to enhance the quality of STEM instruction. The program would provide professional development and training for teachers; purchase, rental, or leasing of equipment, instrumentation, and other scientific educational materials; develop instructional programs to integrate laboratory experiences with classroom instruction; and design and implement hands-on laboratory experiences. A National Research Council report[102] on the state of America's high school labs found that the current quality of laboratory experiences is poor for most students, and schools with higher concentrations of non-Asian minorities and schools with higher concentrations of poor students are less likely to have adequate laboratory facilities than other schools.[103]

Department of Education

The America COMPETES Act authorizes a number of new programs in the Department of Education. The Teachers for a Competitive Tomorrow program would provide grants to institutions of higher education to increase the number of STEM teachers with training in STEM fields. The bachelor degree portion of the program is focused on encouraging undergraduate students already pursuing STEM degrees to concurrently pursue teacher certification. The master's degree portion of the program would encourage current teacher to improve their STEM content knowledge and pedagogical skills through a two- or three-year, part-time, master's degree program. (This program is related to the Robert Noyce Teacher Scholarship program described in the NSF section above.)

The goal of Math Now is to improve instruction in mathematics by providing teachers with research-based tools and professional development to improve elementary and middle school students' achievement in math.

Office of Science and Technology Policy

The America COMPETES Act includes a number of general provisions requiring actions by the President's Office of Science and Technology Policy.[104] For example, the act directs the establishment of a President's Council on Innovation and Competitiveness, and states that the council is to include the Secretary or head of a number of federal agencies, OSTP, and OMB. The chair of the council is to be the Secretary of Commerce. President Bush responded to this requirement by establishing a National Science and Technology Committee (NSTC) on Technology subcommittee.[105] The subcommittee has met several times to respond to the act.[106]

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[102] National Research Council, *America's Lab Report: Investigations in High School Science* (Washington, DC: National Academy Press, 2005) at http://www.nap.edu/catalog.php?record_id=11311.

[103] Testimony of Rep. Rubén Hinojosa, Subcommittee on Research and Science Education, House Science and Technology Committee, *Improving the Laboratory Experience for America's High School Students*, 110th Cong., 1st sess., H.Hrg. 110-9, March 8, 2007, at http://democrats.science.house.gov/Media/File/Commdocs/hearings/2007/research/08mar/hinojosa_testimony.pdf.

[104] For more information on OSTP, see CRS Report RL34736, *The President's Office of Science and Technology Policy (OSTP): Issues for Congress*, by Deborah D. Stine.

[105] White House, "Memorandum for the Director of the Office of Science and Technology Policy," April 10, 2008, at http://www.whitehouse.gov/news/releases/2008/04/20080410-5.html.

The act also states that the President, acting through OSTP, shall convene a National Science and Technology Summit to examine the health and direction of the U.S. science, technology, engineering, and mathematics enterprises. This summit was held on August 18-19, 2008.[107] The act then directs OSTP to submit, as part of the annual budget submission, a description of how the Administration's R&D budget priorities relate to the conclusions and recommendations of the summit.

In addition, the America COMPETES Act directs OSTP to develop an overarching set of principles to ensure the communication and open exchange of data by federal scientists and engineers.

Bush Administration

On May 28, 2008, in response to this requirement, the Bush Administration OSTP sent a memorandum to federal agencies that sponsor research. The memorandum provides guidance and the following "Core Principle for Communication of the Results of Scientific Research Conducted by Scientists Employed by Federal Civilian Agencies":

> Robust and open communication of scientific information is critical not only for advancing science, but also for ensuring that society is informed and provided with objective and factual information to make sound decisions. Accordingly, the Federal government is committed to a culture of scientific openness that fosters and protects the open exchange of ideas, data and information to the scientific community, policymakers, and the public.[108]

The memorandum also indicates that NASA's science communications policy should be a model for other federal agencies.[109] The NASA policy states that, "In keeping with the desire for a culture of openness, NASA employees may, consistent with this policy, speak to the press and the public about their work." Exceptions exist for privileged and other controlled information.

The following are actions designated for OSTP by the America COMPETES Act where no action appears to have been taken by the Bush Administration:

- Study on barriers to innovation;
- National Technology and Innovation Medal;
- Semiannual Science, Technology, and Mathematics Days;
- Study of service science;
- National coordination of research infrastructure;
- Sense of Congress on innovation acceleration research.

(...continued)

[106] E-mail communication between the COT and CRS, September 15, 2008.

[107] For more information, see http://www.ornl.gov/sci/natlscitechsummit/.

[108] OSTP, "Principles for the Release of Scientific Research Results," Memorandum, May 28, 2008, at http://www.ostp.gov/galleries/default-file/Research%20Results.pdf. Note that this memorandum regards the communication of scientific data and information, not science and technology policy.

[109] NASA's policy is available at http://www.nasa.gov/pdf/145687main_information_policy.pdf.

A summary of these activities is provided in **Appendix B** in the section on Title I.

Obama Administration

On February 12, 2009, the Senate Committee on Commerce, Science, and Transportation Committee held a hearing on the Nomination of Dr. John Holdren to be OSTP Director.[110] Dr. Holdren's nomination as OSTP Director was confirmed on March 19, 2009. During his testimony at his nomination hearing, Dr. Holdren stated the following on the issue of the communication of scientific and technical information by federal scientists and engineers:

> Besides efficiency in the use of the available human resources, a further key challenge for OSTP is carrying out its responsibility to ensure the science and technology advice the President and Congress receives, whether from inside or outside the government, is as objective and accurate as the state of the relevant fields permits, regardless of the political implications. If confirmed, I will consider this one of my highest obligations, which would extend to working with the federal agencies that generate and process scientific and technological information to be sure the best technical judgments of the scientists and engineers working there are never censored or distorted for ideological reasons.

In response to a question during the hearing, Dr. Holdren stated the following:

> The America Competes Act, signed into law in August 2007, actually requires the director of the Office of Science and Technology Policy to develop and issue an overarching set of principles to ensure the open communication of data and results from federal scientists, and to prevent the intentional or unintentional suppression or distortion of such research findings.
>
> That's actually a big challenge in thinking about scientific integrity in the federal government. I think getting it done is going to require clarifying policies for disseminating research results, developing processes for appealing those dissemination decisions, providing training to inform, reinforce and update managers, researchers and the public information staffs on those policies.[111]

On March 9, 2009, President Obama issued a memorandum on Scientific Integrity that stated he is assigning OSTP "the responsibility for ensuring the highest level of integrity in all aspects of the executive branch's involvement with scientific and technological processes.... Specifically,

> 1. Within 120 days from the date of this memorandum, the Director shall develop recommendations for Presidential action designed to guarantee scientific integrity throughout the executive branch, based on the following principles:
>
> > (a) The selection and retention of candidates for science and technology positions in the executive branch should be based on the candidate's knowledge, credentials, experience, and integrity;

[110] A webcast of the hearing is available from the Senate Commerce Committee at http://commerce.senate.gov/public/index.cfm?FuseAction=Hearings.Hearing&Hearing_ID=9ba25fea-5f68-4211-a181-79ff35a3c6c6.

[111] Congressional Quarterly Congressional Transcripts, "Senate Commerce, Science, and Transportation Committee Holds Meeting to Organize for the 111th Congress; and Hearing on the Nominations of Jane Lubchenco to Be Undersecretary For Oceans And Atmosphere; and John Holdren to Be Director of the Office of Science and Technology Policy at the Commerce Department," February 12, 2009.

> (b) Each agency should have appropriate rules and procedures to ensure the integrity of the scientific process within the agency;
>
> (c) When scientific or technological information is considered in policy decisions, the information should be subject to well-established scientific processes, including peer review where appropriate, and each agency should appropriately and accurately reflect that information in complying with and applying relevant statutory standards;
>
> (d) Except for information that is properly restricted from disclosure under procedures established in accordance with statute, regulation, Executive Order, or Presidential Memorandum, each agency should make available to the public the scientific or technological findings or conclusions considered or relied on in policy decisions;
>
> (e) Each agency should have in place procedures to identify and address instances in which the scientific process or the integrity of scientific and technological information may be compromised; and
>
> (f) Each agency should adopt such additional procedures, including any appropriate whistleblower protections, as are necessary to ensure the integrity of scientific and technological information and processes on which the agency relies in its decisionmaking or otherwise uses or prepares.
>
> 2. Each agency shall make available any and all information deemed by the Director to be necessary to inform the Director in making recommendations to the President as requested by this memorandum. Each agency shall coordinate with the Director in the development of any interim procedures deemed necessary to ensure the integrity of scientific decisionmaking pending the Director's recommendations called for by this memorandum."[112]

For more information on this topic, see CRS Report RL34736, *The President's Office of Science and Technology Policy (OSTP): Issues for Congress*, by Deborah D. Stine.

Appropriations Status

Table 2 summarizes the FY2008 and FY2009 appropriation and the FY2010 authorization for America COMPETES Act programs.[113] For more information, see CRS Report RL34396, *The America COMPETES Act and the FY2009 Budget*, and CRS Report R40519, *America COMPETES Act and the FY2010 Budget*, both by Deborah D. Stine.

[112] For more information, see http://www.whitehouse.gov/the_press_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-3-9-09/.

[113] The table includes programs for which the America COMPETES Act authorized funding. Not all the programs addressed by the America COMPETES Act had an enumerated authorization of appropriation level. Further, not all of the authorized programs will necessarily be at a sufficient programmatic level to have a line item within their agency's budget in the Bush Administration's request, the appropriations bills, or the agency budgets. Therefore, a lack of an enumerated appropriation does not necessarily mean that a given program is not funded.

Table 2. America COMPETES Act Programs and Appropriations Status

(in millions of dollars)

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
Department of Commerce			
National Institute of Standards and Technology (Sec. 3001)			
—Scientific & Technical Research and Services (STRS) (Sec. 3001)	$440.5	$692.0 (472.0 omnibus + 220.0 ARRA)	$584.8
—Construction & Maintenance (Sec. 3001)	160.5	532.0 (172.0 omnibus +360.0 ARRA)	49.7
—Technology Innovation Program (TIP) (Sec. 3001/3012) [NEW]	65.2[a]	65.0	140.5
—Manufacturing Extension Partnership (MEP) (Sec. 3001/3003)	89.6	110.0	131.8
Department of Energy			
DOE Science, Engineering and Mathematics Programs (Sec. 5003)			
—Pilot Program of Grants to Specialty Schools for Science and Mathematics (Sec. 5003) [NEW]	Not Included	Not Included	30.0
—Experiential Based Learning Opportunities (Sec. 5003) [NEW]	Not Included	Not Included	7.5
—Summer Institutes (Sec. 5003) [NEW]	Not Included	Not Included	25.0

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
—National Energy Education Development (Sec. 5003) [NEW]	Not Included	Not Included	Such sums as necessary
Nuclear Science Talent Expansion Program (Sec. 5004)			
—Nuclear Science Program Expansion Grants for Institutions of Higher Education (Sec. 5004) [NEW]	Not Included	Not Included	9.5
—Nuclear Science Competitiveness Grants for Institutions of Higher Education (Sec. 5004) [NEW]	Not Included	Not Included	8.0
Hydrocarbon Systems Science Talent Expansion Program (Sec. 5005)			
—Hydrocarbon Systems Science Program Expansion Grants for Institutions of Higher Education (Sec. 5005) [NEW]	Not Included	Not Included	9.5
—Hydrocarbon Systems Science Competitiveness Grants for Institutions of Higher Education (Sec. 5005) [NEW]	Not Included	Not Included	8.0
Office of Science (Sec. 5007) (as act amends the Energy Policy Act of 2005 for FY2010)	4,035.6 (3,973.1 consolidated +62.5 supplemental)	6,357.6 4,757.6[b] omnibus +1,600.0 ARRA	5,814.0

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
—Early Career Awards for Science, Engineering, and Mathematics Researchers (Sec. 5006)[NEW]	Not Included	Not Included	25.0
Discovery Science and Engineering Innovation Institutes (Sec. 5008) [NEW]	Not Included	Not Included	10.0-30.0[c]
Protecting America's Competitive Edge (PACE) Graduate Fellowship Program (Sec. 5009)[NEW]	Not Included	Not Included	20.0
Distinguished Scientist Program (Sec. 5011) [NEW]	Not Included	Not Included	30.0
Advanced Research Projects Agency—Energy [ARPA-E] (Sec. 5012) [NEW]	Not Included	*415.0 (15.0 Omnibus + 400.0 ARRA)	Such sums as are necessary
Department of Education			
Teachers for a Competitive Tomorrow: Baccalaureate Degrees (Sec. 6113, 6115, 6116) [NEW]	*0.98	*1.1	151.2
Teachers for a Competitive Tomorrow: Master's Degrees (Sec. 6114-6116) [NEW]	*0.98	*1.1	125.0
Advanced Placement and International Baccalaureate Programs (Sec. 6121-6123) [NEW]	Not Included	*0.0	Such sums as may be necessary
Math Now (Sec. 6201) [NEW]	*0.0	*0.0	Such sums as may be necessary
Summer Term Education Programs (Sec. 6202) [NEW]	Not Included	Not Included	Such sums as may be necessary

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
Math Skills for Secondary School Students (Sec. 6203) [NEW]	Not Included	Not Included	95.0
Advancing America Through Foreign Language Partnership Program[d] (Sec. 6301-6304) [NEW]	Not Included	*0.0	Such sums as may be necessary
P-16 Alignment of Secondary School Graduate Requirements with the Demands of 21st Century Postsecondary Endeavors and Support for P-16 Education Data Systems (Sec. 6401) [NEW]	Not Included	Not Included[e]	Such sums as may be necessary
Mathematics and Science Partnership Bonus Grants (Sec. 6501) [NEW]	Not Included	Not Included	Such sums as may be necessary
National Science Foundation (Sec. 7002)	6,127.5 (6,065.0 consolidated +62.5 supplemental)	9,492.4 (6,490.4 omnibus +3,002.0 ARRA)	8,132.0
Research and Related Activities (R&RA)	4,844.0[f] (4,821.5 consolidated +22.5 supplemental)	7,683.1 (5,183.1 omnibus +2,500.0 ARRA)	6,401.0
—Major Research Instrumentation (MRI) (Sec. 7002/Sec. 7036)	Not Included	*300.0 (Not Included omnibus +300.0 ARRA)	131.7
—Faculty Early Career Development (CAREER) (Sec.7002)	Not Included	Not Included	203.8
—Research Experiences for Undergraduates (REU) (Sec.7002)	Not Included	Not Included	75.9

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
—Experimental Programs to Stimulate Competitive Research (EPSCoR) (Sec.7002)	*120.0 (115.0 consolidated +5.0[g] supplemental)	133.0	147.8
—Integrative Graduate Education and Research Traineeship/R&RA (IGERT) (Sec.7002)[i]	Not Included	Not Included	58.3
—Graduate Research Fellowship/R&RA (GRF) (Sec.7002)	Not Included	Not Included	11.1
—Professional Science Master's Degree Program (Sec. 7002/7034) [NEW]	Not Included	15.0[j] (Not Included omnibus +15.0 ARRA)	15.0
Education and Human Resources (EHR)	765.6 (725.6 consolidated +40.0 supplemental)	945.3 (845.3 omnibus +100.0 ARRA)	1,104.0
—Mathematics and Science Education Partnership (MSP) (Sec.7002/7028)	Not Included	86.0 (*61.0 omnibus +*25.0 ARRA)	123.2
—Robert Noyce Teacher Scholarship Program (Sec.7002/7030)	*55.0 (15.0 consolidated +40.0[k] supplemental)	115.0 (55.0[h] omnibus +*60.0 ARRA)	140.5
—Science, Mathematics, Engineering, and Technology Talent Expansion (Sec.7002/7025)	Not Included	Not Included	55.0
—Advanced Technological Education (ATE) (Sec.7002)	Not Included	Not Included	64.0
—Integrative Graduate Education and Research Traineeship/EHR (IGERT) (Sec.7002)[i]	Not Included	Not Included	33.4
—Graduate Research Fellowship/EHR (GRF) (Sec.7002)	Not Included	*107.0	119.0
Major Research Equipment and Facilities Construction (Sec.7002)	220.7	552.0 (152.0 omnibus +400.0 ARRA)	280.0

Programs with Specific Authorized Budgets in the America COMPETES Act	FY2008 Consolidated Appropriations Act, 2008 (P.L. 110-161); Supplemental Appropriations Act, 2008 (P.L. 110-252))	FY2009 Omnibus Appropriations Act, 2009 (P.L. 111-8); American Recovery and Reinvestment Act (ARRA; P.L. 111-5)	FY2010 America COMPETES Act (P.L. 110-69) Authorization of Appropriation
Agency Operations and Award Management (Sec.7002)	281.8	294.0	329.5
National Science Board (Sec.7002)	4.0	4.0	4.3
Inspector General (Sec.7002)	11.4	14.0 (12.0 omnibus +2.0 ARRA)	13.2
Laboratory Science Pilot Program (Sec. 7026) [NEW]	Not Included	Not Included	Such sums as may be necessary

Source: America COMPETES Act (P.L. 110-69); Omnibus Appropriations Act, 2009 (P.L. 111-8) and explanatory statement; American Recovery and Reinvestment Act of 2009 (P.L. 111-5); H.Conf.Rept. 111-16 and joint explanatory statement. For FY2008, information is from the Consolidated Appropriations Act, 2008 (P.L. 110-161) and joint explanatory statement; Congressional Record, December 17, 2007; Supplemental Appropriations Act, 2008 (P.L. 110-252); H.Rept. 110-240; S.Rept. 110-124; H.Rept. 110-231; and S.Rept. 110-107.

Notes: Section numbers refer to the America COMPETES Act. "[NEW]" means a program that was not authorized prior to the America COMPETES Act. "Not Included" means that these programs were not specifically identified in the budget request, bill, act, or report. * = as reported. All other appropriations are numbers from bill language.

a. The following statement is in the Consolidated Appropriations Act joint explanatory statement: "Of the amounts provided to ITS [Industrial Technology Services], $65,200,000 is for the Technology Innovation Program as authorized by P.L. 110-69 [the America COMPETES Act]. TIP is structured to fund high-risk, high reward research focused on broad national needs such as advanced automotive batteries, aquaculture, novel lightweight materials, and other emerging technologies. The funding provided for TIP will address mortgage obligations relating to projects created under the Advanced Technology Program (ATP). The amended bill also includes language to allow the TIP immediate access to an additional $5,000,000 from deobligations and prior-year recoveries from ATP."

b. The P.L. 111-8 explanatory statement provides $4,772.6 million for science at DOE with $15.0 million of that total for the organizationally separate Advanced Research Projects Agency – Energy (ARPA-E) and the remainder for DOE Office of Science Activities.

c. The Secretary of Energy can decide to establish up to three institutes per fiscal year. Each institute could receive $10 million per year for three fiscal years.

d. The title for this program in the America COMPETES Act is the Foreign Language Partnership Program. The table uses the title for this program from the ED FY2009 congressional budget justification to help distinguish it from other ED foreign language programs such as the existing Foreign Language Assistance program.

e. P.L. 111-5 indicates that part of the funding provided to States for Institutions of Higher Education as part of the State Fiscal Stabilization Fund (Title XIV) should be used for "IMPROVING COLLECTION AND USE OF DATA.—The State will establish a longitudinal data system that includes the elements described in section 6401(e)(2)(D) of the America COMPETES Act (20 U.S.C. 9871)." In addition, the State "will take steps to improve State academic content standards and student academic achievement standards consistent with 6401(e)(1)(A)(ii) of the America COMPETES Act." No specific appropriation is noted for either purpose. Section 6401 of the America COMPETES Act addresses the "Alignment of secondary school graduate requirements with the demands of 21st century postsecondary endeavors and support for P-16

education systems." With that Section, subsection (e)(2)(D) provides required elements of a statewide P-16 education data system such as demographic information, yearly test records, teacher identification information, and student-level transcripts and college readiness test scores. Section (e)(1)(A)(ii) discusses the use of grant funds for "identifying and making changes that need to be made to the State's secondary school graduation requirements, academic content standards, academic achievement standards, and assessments preceding graduation from secondary school in order to align requirements, standards, and assessments with the knowledge and skills necessary for success in academic credit-bearing coursework in postsecondary education, in the 21st century workforce, and in the Armed Forces without the need for remediation."

f. The following statement is in the Consolidated Appropriations Act joint explanatory statement: "The Appropriations Committees strongly support increases for the math and physical sciences, computer sciences, and engineering directorates in fiscal year 2008 for research and related activities (R&RA). However, the Committees also believe the Foundation should maintain comparable growth in fiscal year 2008, to the extent possible, for the biological sciences and social, behavioral and economic sciences directorates. Each of the science disciplines is valuable in maintaining U.S. competitiveness. The Committees urge NSF to provide each directorate with funding levels that are consistent with the goals of the America COMPETES Act and look forward to the Foundation's operating plan in addressing these concerns."

g. Although included in the FY2008 supplemental appropriation, the act specifies a section in the America COMPETES Act authorizing funding for the FY2009 EPSCoR program.

h. The explanatory statement indicates that "The increase provided in the bill for the Noyce Program is for the purpose of expanding participation in the grants program established in section 10 and section 10A of the National Science Foundation Authorization Act of 2002 (42 U.S.C. 1862n-1) as amended by the America COMPETES Act."

i. Two directorates of the NSF manage the Integrative Graduate Education and Research Traineeship (IGERT) program—the Education and Human Resources Directorate (EHR) and the Research and Related Activities (R&RA) directorate. The America COMPETES Act and the NSF budget request both identify the allocations for each directorate.

j. The America COMPETES Act provides the authorization amount within R&RA; however, the explanatory language for P.L. 111-5 places the program within EHR.

k. Of this $40 million, $20 million is for the general Robert Noyce Teacher Scholarship Program, and $20 million is for the NSF Teaching Fellowships and Master Teaching Fellowships that are part of the Noyce program.

Programs Funded at Authorized Levels

A review of **Table 2** finds that the combined funding provided by the Omnibus Appropriation Act (Omnibus) and the American Investment and Recovery Act (ARRA) led to funding of several America COMPETES Act programs at the authorized level (see **Table 3**). Other programs were either funded below authorized levels, or not funded.

Table 3. America COMPETES Act Programs With Appropriated FY2009 Funds Equal or Above Authorized Levels

Program	Authorization	Appropriation
NIST Scientific & Technical Research and Services	$541.9	$692.0
NIST Construction & Maintenance	86.4	532.0
DOE Office of Science	5,200.0	6,357.6
NSF	7,326.0	9,492.4
NSF Research & Related Activities	5,742.3	7,683.1
NSF Major Research Instrumentation	123.1	300.0
NSF Professional Science Master's Degree Program	12.0	15.0
NSF Robert Noyce Teacher Scholarship Program	115.0	115.0
NSF Graduate Research Fellowship Program	107.2	107.0
NSF Major Research Equipment and Facilities Construction	262.0	552.0

Source: Congressional Research Service

Notes: For more details, see **Table 2**. The FY2009 appropriation is a total of that provided by the Omnibus Appropriations Act, 2009 (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5), which supplements that funding.

In the case of ARPA-E, the FY2008 authorization was $300.0 million and the FY2009 authorization is for "such sums as are necessary." The FY2009 appropriation is $415.0 million.

One issue for the future is whether or not these funding levels will be maintained at the authorization level when there may or may not be a supplemental for those funds as was the case in FY2009. If not, this may pose challenges for institutions and individuals sponsored by some programs, particularly those related to research or education.

Programs Presumably Not Funded

As mentioned earlier, a lack of an enumerated appropriation does not necessarily mean that a given program is not funded. At DOE, in particular, the budget proposed in the Bush Administration did not align with that in the America COMPETES Act making it challenging to determine the status of these programs. If the Obama Administration does align its existing programs with the America COMPETES Act, the situation regarding these activities may be clearer. However, at this time, there is insufficient evidence that the following new America COMPETES Act programs are funded:

DOE

- Pilot Program of Grants to Specialty Schools for Science and Mathematics
- Experiential Based Learning Opportunities
- Summer Institutes
- National Energy Education Development
- Nuclear Science Talent Expansion Program
- Hydrocarbon Systems Science Talent Expansion Program
- Early Career Awards for Science, Engineering, and Mathematics Researchers
- Discovery Science and Engineering Innovation Institutes
- Protecting America's Competitive Edge Graduate Fellowship Program
- Distinguished Scientist Program

ED

- Advanced Placement & International Baccalaureate Program
- Math Now
- Summer Term Education Program
- Math Skills for Secondary Skill Students
- Advancing America Through Foreign Language Partnership Program
- Mathematics and Science Partnership Bonus Grants

NSF

- Laboratory Science Pilot Program

Evaluation of the America COMPETES Act

Should Congress decide to appropriate funds for the actions authorized in the America COMPETES Act, how will the nation know if it is successful? The purpose of the act is "to invest in innovation through research and development, and to improve the competitiveness of the United States." (See the earlier discussion on issues related to the definition of competitiveness.)

Many policy actions and other factors influence these indicators beyond the act, so cause and effect is difficult to analyze, but such indicators can provide some understanding of how the overall U.S. economy is faring relative to other countries. The United States currently ranks first on the international competitiveness rankings available. As stated in the legislation, the goal of the act is to maintain this ranking even as other nations increase their science and technology investments and activities.

There are evaluation mechanisms within the act as well as longitudinal analysis conducted by international organizations that assess competitiveness by ranking the ability of the United States

to compete compared with other countries. These mechanisms use a combination of inputs, outputs, and outcomes to make their assessments.

In assessing the nation's competitiveness and the evaluation mechanisms discussed in more depth below, it is important to keep the following caveats in mind.

- There are no direct measures of innovation or competitiveness: numerous indicators of innovation activity are available. These indicators are quantitative assessments of actions that play a role in the innovation process, but adding these indicators together is not necessarily an accurate assessment of innovation or a nation's competitiveness. Other factors such as necessity or serendipity may also play a critical role.
- The ability to evaluate the quality of an innovation, its contribution to improved quality of life, and its value to economic growth is limited and can differ depending on a company or individual's perspective.
- There is no guarantee that inputs, such as increased spending for research and development, will lead to new or enhanced technologies. And, should technologies result or improve, there is no guarantee that they will be "innovative" or used in the marketplace or by society. Further, innovation may occur regardless of research and development due to market demand, perceived need, or minor alterations in existing products and processes.
- The federal government, the industrial sector, and universities all play a major role in funding R&D and innovation. Innovation measures often focus on research and development funding without differentiating between the two. While federal funding of basic research is the primary focus of the America COMPETES Act, the industrial sector also plays a critical development role in technological innovation and advancement in both the public and private sector. University-industry cooperation is also a critical component serving as a liaison between basic research and industry through the education and training of scientists, engineers, and managers.
- In relating R&D funding to gross domestic product, it is important to keep in mind that while much of U.S. R&D funding is for defense-related research, that is not the case in other countries. Analyzing non-defense R&D may provide a different picture than all of R&D.
- In examining industry R&D, the nature of the investment may be an important factor such as the degree of funding spent on research versus development, and the degree of funding spent in particular industrial sectors. For example, more industry funding might be spent on electronic equipment research in one country, while another may spend more of its industrial R&D funding on transportation.
- Although patent data can be an indicator of the state of innovation, not all that results from R&D, such as new ideas, are able to be patented and some companies and individuals choose not to patent in order to prevent disclosure of an idea or plans for an activity, or because of the time needed to obtain a timely patent relative to marketplace needs.
- The number of scientists and engineers may or may not reflect a nation's innovative capacity as new industries have been developed by individuals with and without college degrees.

In sum, there are no guarantees that any particular action will result in innovation or enhanced competitiveness. Instead, the focus of government policy is on creating an environment where innovation has an opportunity to flourish with the result that the United States is competitive with the other nations who are also taking steps to increase their innovation environment. Both international and U.S. government monitoring and assessments of the effect of U.S. policies is important so that policy adjustments can be made as these other nations take policy actions of their own.

Evaluation Mechanisms Within the America COMPETES Act

A number of mechanisms within the act are designed to measure its effectiveness at both the general and program specific level. For example, the act calls for a President's Council on Innovation and Competitiveness whose members include the Secretary or head of departments of independent agencies linked to science and innovation. The Council is to monitor implementation of public laws and initiatives for promoting innovation, provide advice to the President with respect to global trends in competitiveness and innovation, identify opportunities and make recommendations to improve innovation including monitoring and reporting on the implementation of the recommendations, and develop metrics for measuring the progress of the federal government in improving conditions for innovation, including through talent development, investment, and infrastructure improvements.

In addition, there are provisions to evaluate specific research and education programs. For example, in research, ARPA-E is to be evaluated after it has been in operation for four years by the National Academy of Sciences to determine how well ARPA-E is achieving its goals and mission. A similar provision is in place for the Discovery Science and Engineering Innovation Institutes. Current White House guidelines also require federal research programs to be evaluated using the criteria of quality, relevance, and performance in response to the Government Performance and Results Act of 1993 (P.L. 103-62). A merit-based, competitive process is used by agencies in an attempt to determine which research activities, graduate students, distinguished scientists, etc. to fund.

In education, the DOE summer institutes are to submit an annual report to Congress as part of the annual budget submission as to the degree to which the summer institutes improve STEM teaching skills of participating teachers, increase the number of STEM teachers who participate, and improve student academic achievement on State STEM assessments.

Similarly, the recipients of grants in the ED STEM baccalaureate degree with concurrent teacher certification and the Master's program in STEM education are to evaluate their programs and provide information on their ability to increase the number and percentage of new STEM teachers in schools deemed to be most in need, increase the number of underrepresented groups teaching STEM, bring professionals in STEM into the field of teaching, and retain teachers who participate in the program. In addition, the act authorizes conducting an annual independent evaluation to assess the impact of the activities on student academic achievement with a report to the Senate Committee on Health, Education, Labor, and Pensions, the House Committee on Education and Labor, and the Senate and House Committees on Appropriations.

Evaluation Mechanisms Beyond Those in the America COMPETES Act

Mechanisms are also available to monitor and evaluate the status of U.S. competitiveness outside of the act's provisions. These include inputs, outputs, and outcomes.

Outcomes

In terms of outcomes, overall indicators such as the annual World Economic Forum's (WEF) Global Competitiveness Report[114] and the Organisation for Economic Co-operation and Development's (OECD) annual Science, Technology and Industry Scoreboard[115] might be useful. The WEF Global Competitiveness Report rankings are based on publicly available data and an executive opinion survey of over 11,000 business leaders in 131 countries. An illustrative country profile for the United States from the 2007-2008 Global Competitiveness report is shown in **Figure 5.** The OECD Science, Technology and Industry Scoreboard report provides information on innovation by regions and industries, innovation strategies by companies, and patterns in trade competitiveness and productivity. These analyses are both based on a variety of input and output indicators.

Output Indicators

The nation's economic trade balance, foreign direct investment, employment, and wages are examples of output indicators. As discussed earlier in the section discussing the definition of competitiveness, different audiences are interested in different output indicators. The Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), the U.S. Census Bureau, and the National Science Foundation monitor output indicators on a regular basis. The NSF releases a biannual Science and Engineering Indicators report[116] that monitors the health of the science and engineering enterprise that compiles much of this information. The BEA, on behalf of NSF, is currently conducting an experimental analysis that examines the contribution of R&D to GDP growth.

Input Indicators

The quality of education, the availability of a STEM workforce, and the nation's quality and capacity for innovation are examples of input indicators. All of the reports described above monitor input indicators to some extent. These can provide a useful indicator of policy areas on which the United States needs to focus relative to its competitors, and many of these are more directly linked to the act.

[114] World Economic Form, *Global Competitiveness Report 2007-2008*, at http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm.

[115] Organisation for Economic Co-operation and Development, *OECD Science, Technology and Industry Scoreboard 2007*, at http://www.oecd.org/document/10/0,3343,en_2649_33703_39493962_1_1_1_1,00.html#web.

[116] National Science Board, Science and Engineering Indicators 2008 (Arlington, VA: National Science Foundation) at http://www.nsf.gov/statistics/seind08.

For example, although the United States is ranked number one overall in the WEF competitiveness analysis, it does not currently rank number one on each of these input/output indicators in the WEF analysis. Provided below is a list of some of the key sub-indicators related to the America COMPETES Act programs and the U.S. ranking in each of these sub-indicators out of 131 countries (see **Figure 5**):

- quality of primary education (28^{th})
- quality of math and science education in higher education (45^{th})
- capacity for innovation (9^{th})
- quality of scientific research institutions (2^{nd})
- availability of scientists and engineers (12^{th}).[117]

Analysis of state-level competitiveness—relative to other states, not internationally—is also available. Some of the input/output indicators in these analyses are factors that would be influenced by the America COMPETES Act. For example, the Milken Institute uses 77 unique indicators categorized into five major components: human capital investment; research and development inputs; risk capital and entrepreneurial infrastructure; technology and science work force; and technology concentration and dynamism.[118] The Information Technology and Innovation Institute uses factors such as the number of high-tech jobs and scientists and engineers in the workforce and workforce educational attainment.[119] Alera uses factors such as R&D expenditures, human capital, and public education.[120] Suffolk University's Beacon Hill Institute uses factors such as academic R&D funding and STEM degrees.[121]

[117] World Economic Form, Global Competitiveness Report 2007-2008, at http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm.

[118] Milken Institute, *State Science and Technology Index*, June 2008 at http://www.milkeninstitute.org/tech/.

[119] Information Technology and Innovation Institute, *The 2008 State New Economy Index: Benchmarking Economic Transformation in the States*, November 2008 at http://www.itif.org/files/2008_State_New_Economy_Index.pdf.

[120] Alera, *State Knowledge Economy Index, 2007* at http://mightydeck.com/public/mightyshare/AeleraSKEI.pdf.

[121] Beacon Hill Institute, *State Competitiveness Report 2007*, at http://www.beaconhill.org/Compete07/Compete2007State.pdf.

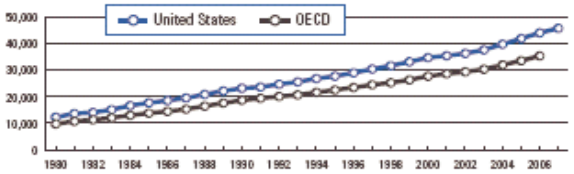
Figure 5. World Economic Forum Analysis of U.S. Competitiveness

United States

Key indicators

Total population (millions), 2007	303.9
GDP (US$ billions), 2007	13,843.8
GDP per capita (US$), 2007	45,845.5
GDP (PPP) as share (%) of world total, 2007	21.36

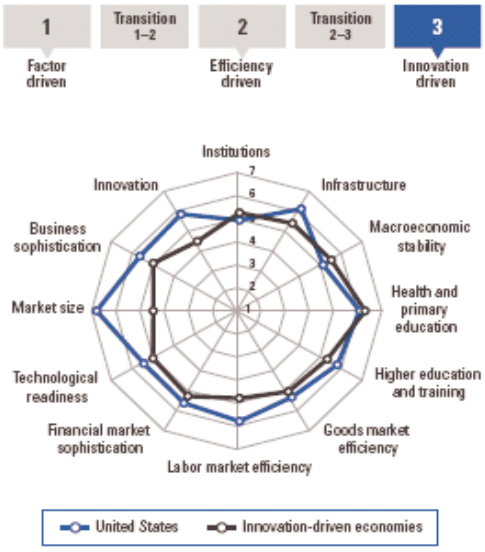
GDP (PPP US$) per capita, 1980–2007



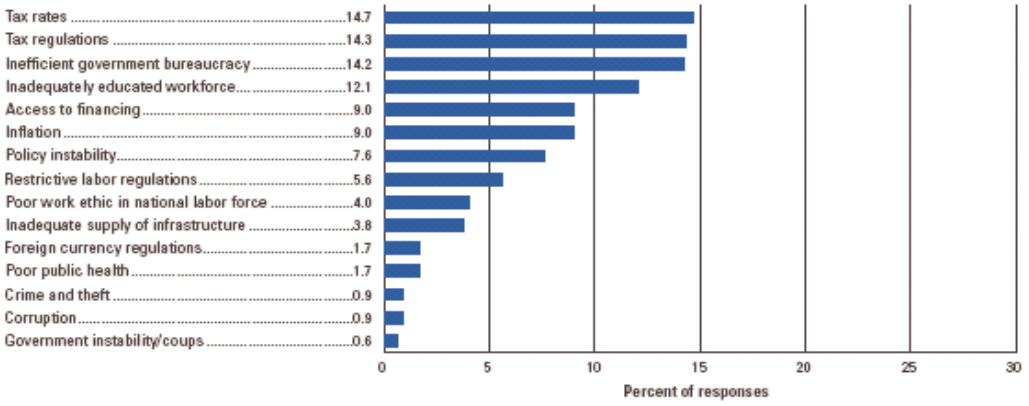
Global Competitiveness Index

	Rank (out of 134)	Score (1–7)
GCI 2008–2009	**1**	**5.7**
GCI 2007–2008 (out of 131)	1	5.7
GCI 2006–2007 (out of 122)	1	5.8
Basic requirements	**22**	**5.5**
1st pillar: Institutions	29	4.9
2nd pillar: Infrastructure	7	6.1
3rd pillar: Macroeconomic stability	66	5.0
4th pillar: Health and primary education	34	6.0
Efficiency enhancers	**1**	**5.8**
5th pillar: Higher education and training	5	5.7
6th pillar: Goods market efficiency	8	5.3
7th pillar: Labor market efficiency	1	5.8
8th pillar: Financial market sophistication	9	5.6
9th pillar: Technological readiness	11	5.6
10th pillar: Market size	1	6.9
Innovation and sophistication factors	**1**	**5.8**
11th pillar: Business sophistication	4	5.8
12th pillar: Innovation	1	5.8

Stage of development



The most problematic factors for doing business



Note: From a list of 15 factors, respondents were asked to select the five most problematic for doing business in their country and to rank them between 1 (most problematic) and 5. The bars in the figure show the responses weighted according to their rankings.

United States

The Global Competitiveness Index in detail

■ Competitive Advantage ■ Competitive Disadvantage

	INDICATOR	RANK/134	
	1st pillar: Institutions		
1.01	Property rights	26	■
1.02	Intellectual property protection	18	■
1.03	Diversion of public funds	22	■
1.04	Public trust of politicians	41	■
1.05	Judicial independence	23	■
1.06	Favoritism in decisions of government officials	40	■
1.07	Wastefulness of government spending	67	■
1.08	Burden of government regulation	50	■
1.09	Efficiency of legal framework	28	■
1.10	Transparency of government policymaking	28	■
1.11	Business costs of terrorism	127	■
1.12	Business costs of crime and violence	83	■
1.13	Organized crime	72	■
1.14	Reliability of police services	18	■
1.15	Ethical behavior of firms	22	■
1.16	Strength of auditing and reporting standards	20	■
1.17	Efficacy of corporate boards	12	■
1.18	Protection of minority shareholders' interests	14	■
	2nd pillar: Infrastructure		
2.01	Quality of overall infrastructure	9	■
2.02	Quality of roads	8	■
2.03	Quality of railroad infrastructure	16	■
2.04	Quality of port infrastructure	11	■
2.05	Quality of air transport infrastructure	12	■
2.06	Available seat kilometers*	1	■
2.07	Quality of electricity supply	16	■
2.08	Telephone lines*	10	■
	3rd pillar: Macroeconomic stability		
3.01	Government surplus/deficit*	97	■
3.02	National savings rate*	107	■
3.03	Inflation*	45	■
3.04	Interest rate spread*	17	■
3.05	Government debt*	102	■
	4th pillar: Health and primary education		
4.01	Business impact of malaria	42	■
4.02	Malaria incidence*	1	■
4.03	Business impact of tuberculosis	39	■
4.04	Tuberculosis incidence*	1	■
4.05	Business impact of HIV/AIDS	76	■
4.06	HIV prevalence*	86	■
4.07	Infant mortality*	36	■
4.08	Life expectancy*	29	■
4.09	Quality of primary education	25	■
4.10	Primary enrollment*	74	■
4.11	Education expenditure*	45	■
	5th pillar: Higher education and training		
5.01	Secondary enrollment*	48	■
5.02	Tertiary enrollment*	6	■
5.03	Quality of the educational system	19	■
5.04	Quality of math and science education	48	■
5.05	Quality of management schools	3	■
5.06	Internet access in schools	11	■
5.07	Local availability of research and training services	1	■
5.08	Extent of staff training	6	■

	INDICATOR	RANK/134	
	6th pillar: Goods market efficiency		
6.01	Intensity of local competition	4	■
6.02	Extent of market dominance	6	■
6.03	Effectiveness of anti-monopoly policy	8	■
6.04	Extent and effect of taxation	56	■
6.05	Total tax rate*	74	■
6.06	No. of procedures required to start a business*	19	■
6.07	Time required to start a business*	6	■
6.08	Agricultural policy costs	69	■
6.09	Prevalence of trade barriers	37	■
6.10	Trade-weighted tariff rate*	33	■
6.11	Prevalence of foreign ownership	47	■
6.12	Business impact of rules on FDI	53	■
6.13	Burden of customs procedures	39	■
6.14	Degree of customer orientation	5	■
6.15	Buyer sophistication	5	■
	7th pillar: Labor market efficiency		
7.01	Cooperation in labor-employer relations	16	■
7.02	Flexibility of wage determination	10	■
7.03	Non-wage labor costs*	26	■
7.04	Rigidity of employment*	1	■
7.05	Hiring and firing practices	6	■
7.06	Firing costs*	1	■
7.07	Pay and productivity	7	■
7.08	Reliance on professional management	10	■
7.09	Brain drain	1	■
7.10	Female participation in labor force*	29	■
	8th pillar: Financial market sophistication		
8.01	Financial market sophistication	3	■
8.02	Financing through local equity market	6	■
8.03	Ease of access to loans	12	■
8.04	Venture capital availability	1	■
8.05	Restriction on capital flows	42	■
8.06	Strength of investor protection*	5	■
8.07	Soundness of banks	40	■
8.08	Regulation of securities exchanges	20	■
8.09	Legal rights index*	16	■
	9th pillar: Technological readiness		
9.01	Availability of latest technologies	5	■
9.02	Firm-level technology absorption	3	■
9.03	Laws relating to ICT	9	■
9.04	FDI and technology transfer	23	■
9.05	Mobile telephone subscribers*	51	■
9.06	Internet users*	9	■
9.07	Personal computers*	6	■
9.08	Broadband Internet subscribers*	18	■
	10th pillar: Market size		
10.01	Domestic market size*	1	■
10.02	Foreign market size*	2	■
	11th pillar: Business sophistication		
11.01	Local supplier quantity	6	■
11.02	Local supplier quality	7	■
11.03	State of cluster development	2	■
11.04	Nature of competitive advantage	12	■
11.05	Value chain breadth	8	■
11.06	Control of international distribution	4	■
11.07	Production process sophistication	11	■
11.08	Extent of marketing	1	■
11.09	Willingness to delegate authority	6	■
	12th pillar: Innovation		
12.01	Capacity for innovation	6	■
12.02	Quality of scientific research institutions	1	■
12.03	Company spending on R&D	3	■
12.04	University-industry research collaboration	1	■
12.05	Gov't procurement of advanced tech products	4	■
12.06	Availability of scientists and engineers	6	■
12.07	Utility patents*	2	■

* Hard data

Note: For further details and explanation, please refer to the section "How to Read the Country/Economy Profiles" at the beginning of this chapter.

Source: World Economic Form, *Global Competitiveness Report 2008-2009*, at http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm.

Concluding Observations

As noted earlier, the America COMPETES Act is an authorization act. New programs established by the act would not be initiated, and authorized increases in appropriations for existing programs would not occur unless funded through subsequent appropriation acts.

The 110th Congress provided FY2008 appropriations to establish ED's Teachers for a Competitive Tomorrow program, and NIST's Technology Improvement Program (TIP), which replaced the existing Advanced Technology Program. The 111th Congress provided FY2009 appropriations to establish DOE's ARPA-E and NSF's PSM program. In addition, portions of the P-16 Alignment of Secondary School Graduate Requirements with the Demands of 21st Century Postsecondary Endeavors and Support for P-16 Education Data Systems was funded through the ARRA.[122] Although some America COMPETES Act research and STEM education programs received appropriations at authorized levels in FY2009, others did not, as described below.

As Congress deliberates the FY2010 budget, an issue for Congress is what level, if any, will it provide America COMPETES Act programs an appropriation, and whether or not the President's budget request will propose to do so. Several programs newly authorized in the act have never been appropriated funds. An issue for these programs is whether or not they will receive the funding necessary to establish them. The America COMPETES Act provides authorization levels only through FY2010.

Now that Congress has decided to fund some America COMPETES Act programs, some policymakers may be observing its impact to determine if the act truly addresses concerns about U.S. competitiveness and the role of the United States in the global economy. For some, this will be the test as to whether U.S. investments in R&D and STEM education can truly enhance the U.S. competitive position.

[122] P.L. 111-5 indicates that part of the funding provided to States for Institutions of Higher Education as part of the State Fiscal Stabilization Fund (Title XIV) should be used for "IMPROVING COLLECTION AND USE OF DATA.—The State will establish a longitudinal data system that includes the elements described in section 6401(e)(2)(D) of the America COMPETES Act (20 U.S.C. 9871)." In addition, the State "will take steps to improve State academic content standards and student academic achievement standards consistent with 6401(e)(1)(A)(ii) of the America COMPETES Act." No specific appropriation is noted for either purpose. Section 6401 of the America COMPETES Act addresses the "Alignment of secondary school graduate requirements with the demands of 21st century postsecondary endeavors and support for P-16 education systems." With that Section, subsection (e)(2)(D) provides required elements of a statewide P-16 education data system such as demographic information, yearly test records, teacher identification information, and student-level transcripts and college readiness test scores. Section (e)(1)(A)(ii) discusses the use of grant funds for "identifying and making changes that need to be made to the State's secondary school graduation requirements, academic content standards, academic achievement standards, and assessments preceding graduation from secondary school in order to align requirements, standards, and assessments with the knowledge and skills necessary for success in academic credit-bearing coursework in postsecondary education, in the 21st century workforce, and in the Armed Forces without the need for remediation."

Appendix A. Summary of Legislative History

The America COMPETES Act (P.L. 110-69) originated as the 21st Century Competitiveness Act of 2007 (H.R. 2272/Gordon) and the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (S. 761/Reid), in the 110th Congress. The Senate passed S. 761 by 88-8 on April 25, 2007. The House passed H.R. 2272 by voice vote on May 21, 2007. On July 19, 2007, the Senate agreed to incorporate S. 761 into H.R. 2272 as an amendment and passed this bill by unanimous consent. A conference committee negotiated the final version of the America COMPETES Act (H.R. 2272) and filed its report on August 1, 2007. The House, by a 367-57 vote, and the Senate, by unanimous consent, both passed the bill on August 2, 2007. The President signed the bill into law (P.L. 110-69) on August 9, 2007.

The act incorporated several House bills that had been introduced, and in some cases passed, earlier in the 110th Congress, including the 10,000 Teachers, 10 Million Minds Science and Math Scholarship Act (H.R. 362/Gordon); the Sowing the Seeds Through Science and Engineering Research Act (H.R. 363/Gordon); an act to amend the High-Performance Computing Act of 1991 (H.R. 1068/Baird); the National Science Foundation Authorization Act of 2007 (H.R. 1867/Baird); the Technology Innovation and Manufacturing Stimulation Act of 2007 (H.R. 1868/Wu); and an act to provide for the establishment of the Advanced Research Projects Agency-Energy (H.R. 364/Gordon). All of these bills were reported by the House Committee on Science and Technology.[123]

In the 109th Congress, the major House bills addressing these issues were the 10,000 Teachers, 10 Million Minds Science and Math Scholarship Act (H.R. 4434/ Gordon); an act to provide for the establishment of the Advanced Research Projects Agency-Energy (H.R. 4435/Gordon), the Sowing the Seeds Through Science and Engineering Research Act (H.R. 4596/Gordon), the Early Career Research Act (H.R. 5356/McCaul), and the Science and Mathematics Education for Competitiveness Act (H.R. 5358/Schwarz). H.R. 5356 and H.R. 5358 were reported by the House Committee on Science.[124]

On the Senate side in the 110th Congress, S. 761 was a reintroduction of a similar bill introduced at the end of the 109th Congress, the National Competitiveness Investment Act [NCIA] (S. 3936/Frist). Senators Frist and Reid, then the majority and minority leaders, respectively, in the 109th Congress, cosponsored S. 3936. Similarly, Senators Reid and McConnell, the Senate majority and minority leaders, respectively, in the 110th Congress introduced S. 761.[125]

The NCIA was based on two bills that were introduced and reported by the relevant Senate committees earlier in the 109th Congress: Protecting America's Competitive Edge Through Energy Act of 2006 [PACE-Energy] (S. 2197/Domenici), reported by the Senate Committee on

[123] The following are the reports for each of the relevant bills in the 110th Congress: H.R. 2272 (H.Rept. 110-289), H.R. 362 (H.Rept. 110-85), H.R. 363 (H.Rept. 110-39), H.R. 364 (ordered to be reported), H.R. 1068 (H.Rept. 110-40), H.R. 1867 (H.Rept. 110-114), and H.R. 1868 (H.Rept. 110-115).

[124] See H.Rept. 109-525 (H.R. 5356) and H.Rept. 109-524 (H.R. 5358) in the 109th Congress. In the 110th Congress, the House Committee on Science was renamed the House Committee on Science and Technology.

[125] Both S. 761 in the 110th Congress and S. 3936 in the 109th Congress went on the Senate calendar with no committee report.

Energy and Natural Resources and the American Innovation and Competitiveness Act (S. 2802/Ensign), reported by the Senate Committee on Commerce, Science, and Transportation.[126]

In the 110th Congress, the provisions of S. 761, S. 2197, H.R. 2272, H.R. 362, H.R. 363, and H.R. 364 and in the 109th Congress, the PACE-Energy bill (S. 2197/Domenici), PACE-Education (S. 2198/Domenici), and PACE-Finance (S. 2199/Domenici) were based largely on the recommendations of the National Academies report *Rising Above the Gathering Storm,*[127] also known as the "Gathering Storm Report" or "Augustine Report."[128] This report was written in response to a request from Senator Lamar Alexander, Senator Jeff Bingaman, Congressman Sherwood Boehlert, and Congressman Bart Gordon. The American Innovation and Competitiveness Act bill (S. 2802/Ensign) was in response to both the Council of Competitiveness report *Innovate America*[129] and the Gathering Storm report.[130]

[126] See S. 2197 (S.Rept. 109-249) and S. 2802 (S.Rept. 109-285) for additional information.

[127] The National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academy Press, 2007). The report was developed by a committee chaired by Norman Augustine. A prepublication version of the report was released in October 2005. Many other bills were also based on the report (e.g., S. 2398/Baucus and S. 2196/Clinton in the 109th Congress). The ones listed here are only those which were reported by a committee for discussion on the Senate or House Floor.

[128] Office of Senator Harry Reid, *Reid Works to Keep America Competitive*, press release, March 5, 2007, at http://reid.senate.gov/newsroom/record.cfm?id=270119&; Office of Senator Pete Domenici, *Domenici, Bingaman & Partners Unveil "Protecting America's Competitive Edge" Legislation*, press release, January 25, 2006; House Committee on Science and Technology, Legislative Highlights, H.R. 2272, The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (COMPETES), July 31, 2007, at http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1938; H.R. 362, "10,000 Teachers, 10 Million Minds." Science and Math Scholarship Act, January 10, 2007, at http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1233; H.R. 363, Sowing the Seeds Through Science and Engineering Research Act, January 10, 2007, at http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1284; H.R. 364, Establishing the Advanced Research Projects Agency - Energy (ARPA-E) Act, January 10, 2007, at http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1235.

[129] Council on Competitiveness, *Innovate America*, 2004, at http://www.innovateamerica.org/webscr/NII_EXEC_SUM.pdf.

[130] Senate Committee on Commerce, Science, and Transportation, *Senate Commerce Committee Approves American Innovation and Competitiveness Act*, press release, May 18, 2006 at http://commerce.senate.gov/public/index.cfm?FuseAction=PressReleases.Print&PressRelease_id=248614&SuppressLayouts=True.

Appendix B. Legislative Information System Summary of America COMPETES Act

America COMPETES Act or America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act

Title I: Office of Science and Technology Policy; Government-Wide Science

(Sec. 1001) Directs the President to: (1) convene a National Science and Technology Summit to examine the health and direction of the United States' science, technology, engineering, and mathematics enterprises; and (2) issue a report on Summit results. Requires, beginning with the President's budget submission for the fiscal year following the conclusion of the Summit and for each of the following four budget submissions, the analytical perspectives component of the budget that describes the research and development (R&D) priorities to include a description of how those priorities relate to the conclusions and recommendations of the Summit.

(Sec. 1002) Requires the: (1) Director of the Office of Science and Technology Policy (OSTP) to contract with the National Academy of Sciences (NAS) to conduct and complete a study to identify, and review methods to mitigate, new forms of risk for businesses beyond conventional operational and financial risk that affect the ability to innovate; and (2) NAS to report study results to Congress. Authorizes appropriations.

(Sec. 1003) Amends the Stevenson-Wydler Technology Innovation Act of 1980 to rename the National Technology Medal established under such Act the National Technology and Innovation Medal.

(Sec. 1004) Expresses the sense of Congress that the OSTP Director should: (1) encourage all elementary and middle schools to observe a Science, Technology, Engineering, and Mathematics Day twice in every school year; (2) initiate a program to encourage federal employees with scientific, technological, engineering, or mathematical skills to interact with school children on such Days; and (3) promote involvement in such Days by appropriate private sector and institution of higher education employees.

(Sec. 1005) Expresses the sense of Congress that the federal government should better understand and respond strategically to the emerging management and learning discipline known as service science. Requires the OSTP Director to study and report to Congress on ways the federal government could support service science through research, education, and training.

(Sec. 1006) Directs the President to establish a President's Council on Innovation and Competitiveness to undertake various activities for promoting innovation and competitiveness in the United States, measure progress in such promotion, and report annually to the President and Congress on such progress. Requires the NAS to submit to the President a list of 50 recommended advisors to such Council.

(Sec. 1007) Requires the Director of OSTP, through the National Science and Technology Council, to: (1) identify and prioritize the deficiencies in research facilities and major instrumentation at federal laboratories and national user facilities at academic institutions that are widely accessible for use by researchers in the United States; and (2) coordinate the planning by federal agencies for the acquisition, refurbishment, and maintenance of research facilities and

major instrumentation to address the deficiencies identified. Requires submission annually to Congress of reports: (1) describing the deficiencies in research infrastructure identified; (2) listing projects and budget proposals of federal research facilities for major instrumentation acquisitions that are included in the President's budget proposal; and (3) explaining how the projects and instrumentation acquisitions relate to the identified deficiencies and priorities.

(Sec. 1008) Expresses the sense of Congress that (1) each federal research agency should strive to support and promote innovation in the United States through high-risk, high-reward basic research projects; and (2) each executive agency that funds research in science, technology, engineering, or mathematics should set a goal of allocating an appropriate percentage of the annual basic research budget of that agency to funding such projects. Requires each such executive agency to report annually with respect to its funding goals.

(Sec. 1009) Requires the OSTP Director to develop and issue a set of principles to ensure the communication and open exchange of data and results to other agencies, policymakers, and the public of research conducted by a scientist employed by a federal civilian agency and to prevent the intentional or unintentional suppression or distortion of such research findings. Requires such principles to take into consideration the policies of peer-reviewed scientific journals in which federal scientists may currently publish results.

Title II: National Aeronautics and Space Administration

(Sec. 2001) Requires that the National Aeronautics and Space Administration (NASA) be a full participant in any interagency effort to promote innovation and economic competitiveness through near- and long-term basic scientific R&D and the promotion of science, technology, engineering, and mathematics education. Requires an annual report from the NASA Administrator to Congress and the President on promotional activities conducted.

Requires the NASA Administrator to submit to Congress a report on its plan for instituting assessments of the effectiveness of NASA's science, technology, engineering, and mathematics education programs in improving student achievement, including with regard to challenging state achievement standards.

(Sec. 2002) Requires the Administrator to coordinate, as appropriate, NASA's aeronautics activities with relevant programs in the Department of Transportation, the Department of Defense (DOD), the Department of Commerce, and the Department of Homeland Security (DHS), including the activities of the Joint Planning and Development Office established under the Vision 100-Century of Aviation Reauthorization Act.

(Sec. 2003) Requires the NASA Administrator, the Director of the National Science Foundation (NSF), and the Secretaries of Energy, Defense, and Commerce to coordinate basic research activities related to physical sciences, technology, engineering, and mathematics.

(Sec. 2004) Expresses the sense of Congress that the NASA Administrator should implement a program to address aging workforce issues in aerospace that (1) documents technical and management experiences before senior people leave NASA; (2) provides incentives for retirees to return and teaches new employees about career lessons and experiences; and (3) provides for development of an award to recognize outstanding senior employees for their contributions to knowledge sharing.

(Sec. 2005) Expresses the sense of Congress that the NASA Administrator should utilize the existing Undergraduate Student Research Program to support basic research projects on subjects of relevance to NASA that (1) are to be carried out primarily by undergraduate students; and (2) combine undergraduate research with other research supported by NASA.

(Sec. 2006) Requires the NASA Administrator to develop: (1) a plan for implementation of at least one education project that utilizes the resources offered by the International Space Station, and in developing any such plan, make use of the findings and recommendations of the International Space Station National Laboratory Education Concept Development Task Force; and (2) a plan for identification and support of research to be conducted aboard the Space Station, which offers the potential for enhancement of U.S. competitiveness in science, technology, and engineering.

Title III: National Institute of Standards and Technology

(Sec. 3001) Authorizes appropriations to the Secretary of Commerce (the Secretary) for the National Institute of Standards and Technology (NIST) for FY2008-FY2010 for: (1) scientific and technical research and services laboratory activities; (2) construction and maintenance of facilities; and (3) Industrial Technology Services activities.

(Sec. 3002) Amends the Stevenson-Wydler Technology Innovation Act of 1980 to repeal provisions regarding the establishment of the Technology Administration within the Department of Commerce. Makes technical and conforming amendments with respect to the Experimental Program to Stimulate Competitive Technology.

Amends the National Institute of Standards and Technology Act to provide for the Director of the NIST to report directly to the Secretary.

(Sec. 3003) Amends the National Institute of Standards and Technology Act to generally revise provisions concerning eligible contributions for the financial support of regional centers responsible for implementing the objectives of the Hollings Manufacturing Extension Partnership Program.

Amends the National Institute of Standards and Technology Act to require that a Manufacturing Center that has not received a positive evaluation shall be notified of the deficiencies in its performance and placed on probation for one year, after which an evaluation panel shall reevaluate such Center. Authorizes the acceptance of funds from other federal departments and agencies and the private sector for the purpose of strengthening U.S. manufacturing. Requires the NIST Director to determine whether funds accepted from other federal departments or agencies shall be counted in calculating the federal share of capital and annual operating and maintenance costs required to create and maintain such Centers.

Establishes within NIST a Manufacturing Extension Partnership (MEP) Advisory Board. Requires such Board to provide to the Director advice on: (1) MEP programs, plans, and policies; (2) assessments of the soundness of MEP plans and strategies; and (3) assessments of current performance against MEP program plans. Requires such Board to transmit annual reports to the Secretary for transmittal to Congress within 30 days after the submission to Congress of the President's annual budget request which shall address the status of the MEP program and comment on the relevant sections of the programmatic planning document and updates thereto transmitted to Congress by the NIST Director pursuant to this title.

Requires the Director to establish within the MEP program a program to award competitive grants among the Centers, or a consortium of such Centers, for the development of projects to solve new or emerging manufacturing problems.

Permits one or more themes for the competition to be identified, which may vary from year to year, depending on the needs of manufacturers and the success of previous competitions. Bars recipients of such grant awards from being required to provide a matching contribution.

(Sec. 3004) Requires the NIST Director, concurrent with submission to Congress of the President's annual budget request, to transmit a three-year programmatic planning report for NIST, including programs under the Scientific and Technical Research and Services, Industrial Technology Services, and Construction of Research Facilities functions, and subsequent updates.

(Sec. 3005) Amends the National Institute of Standards and Technology Act to provide that annual reports to the Secretary and Congress be submitted by the Visiting Committee on Advanced Technology not later than 30 days (under current law, on or before January 31 in each year) after the submittal to Congress of the President's annual budget request. Requires that such report also comment on the programmatic planning document and updates thereto submitted to Congress by the Director.

(Sec. 3006) Amends the National Institute of Standards and Technology Act to provide for the Visiting Committee on Advanced Technology to meet at least twice each year (under current law at least quarterly) at the call of the chairman of the Committee or whenever one-third of the Committee's members so request in writing.

(Sec. 3007) Requires the Director to establish a manufacturing research pilot grants program to make awards to partnerships to foster cost-shared collaborations among firms, educational and research institutions, state agencies, and nonprofit organizations in the development of innovative, multidisciplinary manufacturing technologies. Requires such partnerships to include at least one manufacturing industry partner and one nonindustry partner.

Requires partnerships receiving awards to conduct applied research to develop new manufacturing processes, techniques, or materials that would contribute to improved performance, productivity, and competitiveness of U.S. manufacturing, and build lasting alliances among collaborators. Bars: (1) awards from providing for not more than one-third of the costs of a partnership; and (2) not more than an additional one-third of such costs from being obtained directly or indirectly from other federal sources.

Instructs the Director, in selecting applications, to ensure, a distribution of overall awards among a variety of manufacturing industry sectors and a range of firm sizes.

Requires the Director to run a single pilot competition to solicit and make awards. Limits each award to a three-year period.

(Sec. 3008) Requires the Director, in order to promote the development of a robust research community working at the leading edge of manufacturing sciences, to establish a program to award: (1) postdoctoral research fellowships at NIST for research activities related to manufacturing sciences; and (2) senior research fellowships to establish researchers in industry or at institutions of higher education who wish to pursue studies related to the manufacturing sciences at NIST. Requires the Director to provide stipends for post-doctoral research fellowships

at a level consistent with the National Institute of Standards and Technology Postdoctoral Research Fellowship Program, and senior research fellowships at levels consistent with support for a faculty member in a sabbatical position.

(Sec. 3009) Allows the Director, through September 30, 2010, to annually procure the temporary or intermittent services of up to 200 experts or consultants to assist with urgent or short-term projects.

Directs the Comptroller General to report on whether additional safeguards would be needed with respect to the use of such authority if it were to be made permanent.

(Sec. 3010) Amends the Stevenson-Wydler Technology Innovation Act of 1980 to revise the limitation on the number of Malcolm Baldrige National Quality Awards that may be made in any year by permitting not more than 18 awards to be made in any year to recipients who have not previously received such an award. Prohibits any award from being made within any category in which such an award may be given if there are no qualifying enterprises in that category.

(Sec. 3011) Requires the NIST Director to submit a report on efforts to recruit and retain young scientists and engineers at the early stages of their careers at the NIST laboratories and joint institutes.

(Sec. 3012) Abolishes the Advanced Technology Program (ATP) and replaces it with the Technology Innovation Program (TIP), while continuing support originally awarded under ATP. Provides for TIP to assist U.S. businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutions, to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need.

Requires the Director to award competitive, merit-reviewed grants, cooperative agreements, or contracts to: (1) eligible companies that are small or medium-sized businesses; or (2) joint ventures. Sets forth limitations on single company and joint venture awards. Limits the federal share of a project funded by an award under TIP to not more than half of total project costs. Bars any business that is not a small or medium-sized business from receiving any funding under TIP.

Requires the Director to solicit proposals at least annually to address areas of critical national need for high-risk, high-reward projects.

Requires: (1) the NIST Director to submit annually reports on TIP's activities; and (2) the first annual report to include best practices for management of programs to stimulate high-risk, high-reward research.

Requires the Director, in carrying out TIP, as appropriate, to coordinate with other senior state and federal officials to ensure cooperation and coordination in state and federal technology programs and to avoid unnecessary duplication of efforts. Requires that funds accepted from other federal agencies be included as part of the federal cost share of any project funded under TIP.

Establishes within NIST a TIP Advisory Board. Requires such Board to provide to the Director: (1) advice on programs, plans, and policies of TIP; (2) reviews of Tip's efforts to accelerate the R&D of challenging, high-risk, high-reward technologies in areas of critical national need; (3) reports on the general health of the program and its effectiveness in achieving its legislatively mandated mission; and (4) guidance on investment areas that are appropriate for TIP funding.

Requires such Board to transmit annual reports to the Secretary for transmittal to Congress not later than 30 days after the submission to Congress of the President's annual budget request which shall address the status of TIP and comment on the relevant sections of the programmatic planning document and updates thereto transmitted to Congress by the Director.

Defines "high-risk, high-reward research" to mean research that (1) has the potential for yielding transformational results with far-ranging or wide-ranging implications; (2) addresses critical national needs within NIST's areas of technical competence; and (3) is too novel or spans too diverse a range of disciplines to fare well in the traditional peer review process.

Requires the NIST Director to carry out ATP as it was in effect before the enactment of this act with respect to applications for grants under ATP submitted before such date, until the earlier of: (1) the date that the Director promulgates the regulations required by this act for the operation of TIP required under this act; or (2) December 31, 2007.

(Sec. 3013) Amends the National Institute of Standards and Technology Act to: (1) increase funding for research fellowships and other financial assistance to students at institutions of higher education within the United States and to U.S. citizens for research and technical activities on NIST programs; (2) add as a function of the Secretary and NIST, the authority to enter into contracts which include grants and cooperative agreements to further the purposes of NIST; (3) repeal the act of July 21, 1950 (relating to the legal units of electrical and photometric measurement in the United States and relating to the establishment of the values of the primary electric and photometric units in absolute measure and the legal values for these units); and (4) repeal the non-energy inventions program.

(Sec. 3014) Authorizes the Director to retain all building use and depreciation surcharge fees collected pursuant to OMB Circular A-25 (relating to fees assessed for government services and for sale or use of government goods or resources). Requires such fees to be collected and credited to the construction of research facilities appropriation account for use in maintenance and repair of NIST's existing facilities.

(Sec. 3015) Amends the National Institute of Standards and Technology Act to double the number of fellows per fiscal year to be included in the postdoctoral fellowship program.

Title IV: Ocean and Atmospheric Programs

(Sec. 4001) Directs the Administrator of the National Oceanic and Atmospheric Administration (NOAA) to establish a program of ocean, coastal, Great Lakes, and atmospheric R&D, in collaboration with academic institutions and other nongovernmental entities, to focus on the development of advanced technologies and methods to promote U.S. leadership in ocean and atmospheric science as well as competitiveness in applied uses of such R&D.

(Sec. 4002) Requires the NOAA Administrator to: (1) conduct, develop, support, promote, and coordinate educational activities to enhance public awareness and understanding of ocean, coastal, Great Lakes, and atmospheric science and stewardship by the general public and other coastal stakeholders; and (2) develop a 20-year ocean, coastal, and atmospheric science education plan.

(Sec. 4003) Requires that NOAA be a full participant in any interagency effort to promote innovation and economic competitiveness through basic scientific R&D and the promotion of science, technology, engineering, and mathematics education.

Title V: Department of Energy—Protecting America's Competitive Edge Through Energy Act, or the PACE-Energy Act

(Sec. 5003) Amends the Department of Energy Science Education Enhancement Act (Act) to require the Secretary of Energy (Secretary in this title), acting through the Under Secretary for Science, to: (1) appoint a Director of Science, Engineering, and Mathematics Education (Director) to administer science, engineering, and mathematics education programs across all functions of the Department of Energy (DOE); and (2) offer to contract with the National Academy of Sciences (NAS) to assess the performance of such programs.

Directs the Secretary to establish a Science, Engineering, and Mathematics Education Fund.

Requires the Secretary, acting through the Director, to: (1) award competitive grants to states in a pilot program to assist them in establishing or expanding public, statewide specialty secondary schools that provide comprehensive science and mathematics; and (2) establish a summer internship program for middle school and secondary school students to provide experiential-based learning opportunities at the National Laboratories.

Directs the Secretary to establish at each of the National Laboratories: (1) a program to support a Center of Excellence in Science, Technology, Engineering, and Mathematics in at least one high-need public secondary school; (2) programs of summer institutes to provide additional training to strengthen the science, technology, engineering, and mathematics teaching skills of teachers employed at public schools for kindergarten through grade 12 (K-12); and (3) a program to coordinate and make available to teachers and students web-based kindergarten through high school science, technology, engineering, and mathematics education resources relating to the DOE science and energy mission.

Instructs the Director to establish a recruiting and mentoring program for women and underrepresented minorities to pursue careers in science, engineering, and mathematics.

Directs the Secretary to award each fiscal year to institutions of higher education: (1) up to three competitive grants for new academic degree programs in nuclear science; (2) up to five competitive grants for existing academic degree programs that produce graduates in nuclear science; (3) up to three competitive grants for new academic degree programs in hydrocarbon systems science; (4) up to five competitive grants for existing academic degree programs that produce graduates in hydrocarbon systems science. Authorizes appropriations for FY2008-FY2010.

(Sec. 5006) Instructs the Director of the DOE Office of Science to: (1) award grants to scientists and engineers at an early career stage at certain institutions of higher education, organizations, or National Laboratories to conduct research in fields relevant to the DOE mission; and (2) report to certain congressional committees on the Director's efforts to recruit and retain young scientists and engineers at early career stages at the National Laboratories.

(Sec. 5007) Amends the Energy Policy Act of 2005 to authorize FY2010 appropriations for research, development, demonstration, and commercial application activities of the Office of Science.

(Sec. 5008) Directs the Secretary to establish: (1) distributed, multidisciplinary institutes centered at National Laboratories to apply fundamental scientific and engineering discoveries to technological innovations relating to the DOE mission and the global competitiveness of the United States; and (2) a Protecting America's Competitive Edge (PACE) graduate fellowship program for students pursuing a doctoral degree in a DOE mission area. Authorizes appropriations for FY2008-FY2010.

(Sec. 5010) Expresses the sense of Congress that (1) DOE should implement the recommendations contained in the report of the Government Accountability Office numbered 04-639; and (2) the Secretary should conduct annual reviews in accordance with title IX of the Education Amendments of 1972 of at least two DOE grant recipients.

(Sec. 5011) Instructs the Secretary to establish a program to support the joint appointment of distinguished scientists by institutions of higher education and by the National Laboratories. Authorizes appropriations for FY2008-FY2010.

(Sec. 5012) Establishes within DOE the Advanced Research Projects Agency-Energy (ARPA-E) to overcome long-term and high-risk technological barriers in the development of energy technologies.

Directs the Secretary after four years to offer to contract with the NAS to evaluate how well ARPA-E is achieving its goals and mission.

Establishes in the Treasury the Energy Transformation Acceleration Fund to implement the ARPA-E program.

Authorizes appropriations for FY2008-FY2010.

Title VI: Education

Subtitle A: Teacher Assistance

Part I: Teachers for a Competitive Tomorrow—(Sec. 6113) Authorizes the Secretary of Education (Secretary, for purposes of this Title) to award competitive matching grants to enable educational partnerships to develop and implement programs to provide courses of study in science, technology, engineering, mathematics, or critical foreign languages that (1) are integrated with teacher education; and (2) lead to a baccalaureate degree with concurrent teacher certification.

(Sec. 6114) Authorizes the Secretary to award competitive matching grants to educational partnerships to develop and implement: (1) two- or three-year part-time master's degree programs in science, technology, engineering, mathematics, or critical foreign language education for teachers in order to enhance the teachers' content knowledge and teaching skills; or (2) programs for professionals in science, technology, engineering, mathematics, or a critical foreign language that lead to a one-year master's degree in teaching that results in teacher certification.

(Sec. 6115) Directs the Secretary to award each of the above grants for up to five years. Requires 50% nonfederal matching funds.

(Sec. 6116) Authorizes appropriations.

Part II: Advanced Placement and International Baccalaureate Programs—(Sec. 6123) Authorizes the Secretary to award competitive matching grants for up to five-year periods to enable educational agencies or partnerships to carry out activities designed to increase the number of: (1) qualified teachers serving high-need (low-income or rural area) schools who are teaching advanced placement or international baccalaureate courses in mathematics, science, or critical foreign languages; and (2) students attending such schools who enroll in and pass the examinations for such courses.

Requires 200% nonfederal matching funds, but requires no more than 100% from high-need local educational agencies (LEAs). Permits the Secretary to waive the match for educational agencies if it would cause them serious hardship or prevent them from carrying out the program.

Part III: Promising Practices in Science, Technology, Engineering, and Mathematics Teaching—(Sec. 6131) Requires the Secretary to contract with the National Academy of Sciences (NAS) to convene an expert panel to identify promising practices for, and synthesize the scientific evidence pertaining to, improving the teaching and learning of science, technology, engineering, and mathematics in kindergarten through grade 12. Requires the dissemination of the panel's findings and recommendations to the public and state and local educational agencies. Authorizes appropriations.

Subtitle B: Mathematics

(Sec. 6201) Authorizes the Secretary to award competitive three-year matching grants to states and, through them, subgrants to high-need LEAs to: (1) implement mathematics programs or initiatives that are research-based; (2) provide professional development and instructional leadership activities for teachers and administrators on the implementation of mathematics initiatives; and (3) conduct student mathematics progress monitoring and identify areas in which students need help in learning mathematics. Applies the program to students and teachers in kindergarten through grade 9. Requires state grantees to contribute 50% of program costs. Authorizes appropriations.

(Sec. 6202) Directs the Secretary to carry out a demonstration program under which the Secretary awards up to five grants each fiscal year to states for the provision of summer learning grants to disadvantaged students. Requires the summer programs to emphasize mathematics, technology, engineering, and problem-solving through experiential learning opportunities. Limits to 50% the federal share of such grants. Authorizes appropriations.

(Sec. 6203) Requires the Secretary to establish a program that provides competitive three-year matching grants to states and, through them, subgrants to eligible LEAs to establish new services and activities to improve the overall mathematics performance of secondary school students. Provides: (1) a minimum grant amount of $500,000; and (2) a state matching funds requirement of 50% of program costs. Authorizes appropriations.

(Sec. 6204) Directs the Secretary to establish peer review panels to review state applications for the mathematics grant programs, excluding the demonstration grant program.

Subtitle C: Foreign Language Partnership Program

(Sec. 6303) Authorizes the Secretary to award grants to enable partnerships of institutions of higher education and LEAs to establish programs of study in critical foreign languages that will enable students to advance successfully from elementary school through postsecondary education and achieve higher levels of proficiency in such languages. Makes such grants for five-year periods, authorizing the Secretary to renew them for up to two additional five-year periods. Outlines matching funds requirements.

(Sec. 6304) Authorizes appropriations.

Subtitle D: Alignment of Education Programs

(Sec. 6401) Authorizes the Secretary to award competitive grants to enable states to work with statewide partnerships to: (1) promote better alignment of content knowledge requirements of secondary school graduation with the knowledge and skills needed to succeed in postsecondary education, the 21st century workforce, or the Armed Forces; or (2) establish or improve statewide P-16 (preschool through baccalaureate degree) education data systems. Requires each state to match grant fund amounts. Authorizes appropriations.

Subtitle E: Mathematics and Science Partnership Bonus Grants

(Sec. 6501) Directs the Secretary to award grants, during school years 2007-2008 through 2010-2011, to each of the three elementary and three secondary schools with a high concentration of low-income students in each state whose students demonstrate the most improvement in mathematics and science, respectively.

(Sec. 6502) Authorizes appropriations.

Title VII: National Science Foundation

(Sec. 7002) Authorizes appropriations for FY2008-FY2010 to the National Science Foundation (NSF) for: (1) research and related activities; (2) education and human resources; (3) major research equipment and facilities construction; (4) agency operations and award management; (5) the Office of the National Science Board; and (6) the Office of Inspector General.

(Sec. 7003) Prohibits anything in this title or title I from being construed to alter or modify the NSF merit-review system or peer-review process.

(Sec. 7004) Expresses the sense of Congress that the Director of the NSF and the Secretary of Education should have ongoing collaboration to ensure that their respective mathematics and science partnership programs continue to work in concert (and not duplicatively) for the benefit of states and local practitioners.

(Sec. 7005) Prohibits anything in this title from being construed to limit the authority of state governments or local school boards to determine the curricula of their students.

(Sec. 7006) Requires the continuation of the program of Centers for Research on Learning and Education Improvement as established in section 11 of the National Science Foundation Authorization Act of 2002 (relating to the establishment of such Centers).

Amends the National Science Foundation Authorization Act of 2002 to provide for the awarding of grants to eligible nonprofit organizations and their consortia to establish such Centers.

(Sec. 7007) Directs the National Science Board to evaluate: (1) the role of NSF in supporting interdisciplinary research, including through the Major Research Instrumentation program, the effectiveness of NSF's efforts in providing information to the scientific community about opportunities for funding of interdisciplinary research proposals, and the process through which interdisciplinary proposals are selected for support; and (2) the effectiveness of NSF's efforts to engage undergraduate students in research experiences in interdisciplinary settings, including through the Research in Undergraduate Institutions program and the Research Experiences for Undergraduates program. Requires the Board to provide the results of its evaluation, including a recommendation for the proportion of the NSF's research and related activities funding that should be allocated for interdisciplinary research.

(Sec. 7008) Instructs the Director to: (1) require that all grant applications that include funding to support postdoctoral researchers include a description of mentoring activities; and (2) ensure that this part of the application is evaluated under NSF's broader impacts merit review criterion. Instructs the Director to require that annual reports and the final report for research grants that include funding to support postdoctoral researchers include a description of the mentoring activities provided to such researchers.

(Sec. 7009) Instructs the Director to require that each institution that applies for financial assistance from NSF for science and engineering research or education describe in its grant proposal a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to participating undergraduate students, graduate students, and postdoctoral researchers.

(Sec. 7010) Instructs the Director to ensure that all final project reports and citations of published research documents resulting from research funded, in whole or in part, by the NSF are made available to the public in a timely manner and through NSF's website.

(Sec. 7011) Makes an investigator supported under a NSF award, whom the Director determines has failed to comply with the provisions of section 734 (concerning the dissemination and sharing of research results) of the Foundation Grant Policy Manual, ineligible for a future award under any NSF supported program or activity. Allows the Director to restore the eligibility of such an investigator on the basis of the investigator's subsequent compliance with such provisions and with such other terms and conditions as the Director may impose.

(Sec. 7012) Requires the Director to annually evaluate all NSF's grants that are scheduled to expire within one year and that primarily: (1) meet the objectives of the Science and Engineering Equal Opportunity Act; or (2) provide teacher professional development. Allows the Director, for grants that are identified and that are deemed by the Director to be successful in meeting the objectives of the initial grant solicitation, to extend those grants for not more than three additional years beyond their scheduled expiration without the requirement for a recompetition. Requires the Director to annually submit a report that (1) lists the grants extended; and (2) provides recommendations regarding the extension of such authority to programs other than those specified in this section.

(Sec. 7013) Requires the National Science Board to: (1) evaluate certain impacts of its policy to eliminate cost sharing for research grants and cooperative agreements for existing and new programs involving industry participation; and (2) report the results of such evaluation.

(Sec. 7014) Requires the National Science Board to evaluate the appropriateness of: (1) the requirement that funding for detailed design work and other preconstruction activities for major research equipment and facilities come exclusively from the sponsoring research division rather than being available from the Major Research Equipment and Facilities Construction account; and (2) NSF's policies for allocation of costs for, and oversight of, maintenance and operation of major research equipment and facilities.

Requires the Board to report on the results of such evaluations and on any recommendations for modifying the current policies related to allocation of funding for such equipment and facilities. Requires that plans for proposed construction, repair, and upgrades to national research facilities include estimates of the total project cost and the source of funds for major upgrades of facilities in support of Antarctic research programs.

Requires the Director to transmit: (1) a specified report cataloging all elementary and secondary school, informal, and undergraduate educational programs and activities supported through appropriations for research and related activities; and (2) as part of the President's FY2011 budget submission, a report listing the funding success rates and distribution of awards for the Research in Undergraduate Institutions program.

Requires the Director, not later than 60 days after enactment of legislation providing for the annual appropriation of funds for NSF, to submit a plan for the allocation of education and human resources funds authorized by this title for the corresponding fiscal year, including any funds from within the research and related activities account used to support activities that primarily improve education or broaden participation.

(Sec. 7015) Amends the National Science Foundation Authorization Act of 2002 to require: (1) the Inspector General of NSF to conduct triennial audits (currently, annual audits) of the compliance by the National Science Board with the requirements specified under the act for open meetings; (2) the Board to maintain the General Counsel's certificate, the presiding officer's statement, and a transcript or recording of any closed meeting for at least three years after such meeting; and (3) appointment of technical and professional personnel on leave of absence from academic, industrial, or research institutions for a limited term and such operations and support staff members (currently, such clerical staff members) as may be necessary.

Amends the National Science Foundation Authorization Act of 1976 to limit the number of Alan T. Waterman Awards that may be made in any one fiscal year to not more than three (under current law, to no more than one).

(Sec. 7016) Requires rendering of National Science Board reports to the President and Congress (under current law, rendered to the President for submission to Congress).

(Sec. 7017) Amends the Program Fraud Civil Remedies Act of 1986 to include the NSF as an authority with respect to the provisions of such Act relating to administrative remedies for false claims and statements.

(Sec. 7018) Requires the NSF Director to: (1) consider the degree to which NSF-eligible awards and research activities may assist in meeting critical national needs in innovation, competitiveness, safety and security, the physical and natural sciences, technology, engineering, social sciences, and mathematics; and (2) give priority in the selection of NSF awards, research resources, and grants to entities that can be expected to make contributions in physical or natural science, technology, engineering, social sciences, or mathematics, or that enhance competitiveness, innovation, or safety and security.

(Sec. 7019) Permits the NSF, in carrying out its research programs on science policy and on the science of learning, to support research on the process of innovation and the teaching of inventiveness.

(Sec. 7020) Requires the NSF Director to develop and publish a plan describing the current status for broadband access for scientific research purposes at institutions in EPSCoR (Experimental Program to Stimulate Competitive Research) eligible states, at institutions in rural areas, and at minority serving institutions and outlines actions to ensure that such connections are available to participate in NSF programs that rely heavily on high-speed networking and collaborations across institutions and regions.

(Sec. 7021) Requires the NSF Director to carry out a pilot program to award one-year grants to individuals to assist them in improving research proposals that were previously submitted to NSF but not selected for funding. Requires that such grants be used to enable individuals to resubmit updated research proposals for review by NSF through NSF's competitive merit review process.

Requires the Director to make awards under this section based on the advice of program officers of the NSF.

Permits using funds made available under this section for the generation of new data and the performance of additional analysis.

Allows the Director to carry out this section through the Small Grants for Exploratory Research program.

Directs the National Science Board to conduct a review and assessment of the pilot program.

(Sec. 7022) States that, among the types of activities that the NSF shall consider as appropriate for meeting the requirements of its broader impacts criterion for the evaluation of research proposals are partnerships between academic researchers and industrial scientists and engineers that address research areas identified as having high importance for future national economic competitiveness, such as nanotechnology. Requires the Director to report on the impact of the broader impacts grant criterion used by NSF.

(Sec. 7023) Amends the National Science Foundation Act of 1950 to permit NSF to receive and use funds donated to NSF for specific prize competitions for "basic research" as defined in the Office of Management and Budget Circular No. A-11 (Preparation, Submission, and Execution of the Budget).

(Sec. 7024) Amends the High-Performance Computing Act of 1991 to revise program requirements for the National High-Performance Computing Program.

Requires the Director of the Office of Science and Technology Policy to: (1) establish the goals and priorities for federal high-performance computing research, development, networking, and other activities; (2) establish Program Component Areas that implement such goals and identify the Grand Challenges (i.e., fundamental problems in science or engineering, with broad economic and scientific impact, whose solutions will require the application of high-performance computing resources and, as amended by this section, multidisciplinary teams of researchers) that the Program should address; and (3) develop and maintain a research, development, and deployment road map covering all states and regions for the provision of high-performance computing and networking systems.

Revises requirements for annual reports by requiring that such reports: (1) describe Program Component Areas, including any changes in the definition of or activities under such Areas and the reasons for such changes, and describe Grand Challenges supported under the Program; (2) describe the levels of federal funding and the levels proposed for each Program Component Area; (3) describe the levels of federal funding for each agency and department participating in the Program for each such Area; and (4) include an analysis of the extent to which the Program incorporates the recommendations of the advisory committee on high-performance computing. Eliminates the requirement for inclusion of reports on Department of Energy activities taken to carry out the National High-Performance Computing Program.

Requires the advisory committee on high-performance computing to conduct periodic evaluations of the funding, management, coordination, implementation, and activities of the Program, and to report at least once every two fiscal years to specified congressional committees. Prohibits applying provisions for the termination, renewal, and continuation of federal advisory committees under the Federal Advisory Committee Act to such advisory committee.

Instructs the NSF, as part of the Program, to support basic research related to advanced information and communications technologies that will contribute to enhancing or facilitating the availability and affordability of advanced communications services for all people of the United States. Requires the NSF Director to award multiyear grants to institutions of higher education, nonprofit research institutions affiliated with such institutions, or their consortia to establish multidisciplinary Centers for Communications Research. Increases funding for the basic research activities described in this section, including support for such Centers. Requires the NSF Director to transmit to Congress, as part of the President's annual budget submission, reports on the amounts allocated for support of research under this section.

(Sec. 7025) Revises the Science, Mathematics, Engineering, and Technology Talent Expansion program to require the Director to issue grants to institutions of higher education for the creation of not more than five centers to increase the number of students completing undergraduate courses in science, technology, engineering, and mathematics and to improve student academic achievement in such courses.

Requires the NSF Director to strive to increase the representation of students from public secondary schools that serve students from families with incomes below the poverty line or are designated with a school locale code of 41, 42, or 43, as determined by the Secretary of Education when providing grants under the Talent Expansion program to increase the number of students studying and completing associate's or bachelor's degrees, concentrations, or certificates in science, technology, engineering, or mathematics by giving priority to programs that heavily recruit female, minority, and disabled students who are from such schools.

(Sec. 7026) Requires the NSF Director to establish a Partnerships for Access to Laboratory Science research pilot program for awarding grants to partnerships to improve laboratories and provide instrumentation as part of a comprehensive program to enhance the quality of science, technology, engineering, and mathematics instruction in secondary schools. Requires such partnerships to include significant teacher preparation, unless such preparation is addressed through other means.

Limits the federal share of partnership costs to 40%.

Requires the Director to report to specified congressional committees not later than five years regarding the program's effect on student achievement.

Sunsets the provisions of this section on the last day of FY2010.

Authorizes appropriations for the program for FY2008-FY2010.

(Sec. 7027) Requires the NSF Director to report to Congress not later than two years on the extent to which institutions of higher education and private entities are donating used laboratory equipment to elementary and secondary schools.

(Sec. 7028) Revises requirements for the Mathematics and Science Education Partnership program (Partnership program), which provides grants to institutions of higher education or nonprofit organizations for the improvement of elementary and secondary mathematics and science instruction.

Includes the department, college, or program of education at an institution of higher education, in addition to LEAs, state educational agencies, and businesses, among the entities with which institutions of higher education and nonprofit organizations may partner.

Adds to the list of grant fund uses: (1) professional development activities to prepare mathematics and science teachers to teach challenging mathematics, science, and technology college-preparatory courses; (2) laboratory training and support for teachers; (3) induction programs (as defined by in section 6113 of this act) for teachers in their first two years of teaching; (4) technology and engineering, in addition to mathematics and science, in the student enrichment programs which are to include after-school programs and summer programs for female, minority, and disabled students; and (5) the development and dissemination of curriculum tools that foster inventiveness and innovation. Requires grantees providing challenging college preparatory courses to encourage companies employing scientists, technologists, engineers, or mathematicians to provide mentors to teachers and students.

Requires the Director to transmit to Congress not later than four years of this act's enactment, a summary of partnership evaluations that describes recommended changes to the program.

(Sec. 7029) Amends the National Science Foundation Authorization Act of 2002 to provide additional Program requirements for the NSF Teacher Institutes for the 21st Century.

(Sec. 7030) Amends the National Science Foundation Authorization Act of 2002 concerning the Robert Noyce Scholarship Program to: (1) rename such Program the Robert Noyce Teacher Scholarship Program and rewrite Program requirements, including by allowing participation in the Program by an institution of higher education that receives grant funds on behalf of a consortium of institutions of higher education; and (2) require the NSF Director to establish a

separate program to award grants to eligible entities to enable them to administer NSF Teaching Fellowships and Master Teaching Fellowships according to this section. Requires that grants be used by participating partnerships to develop and implement a program to recruit and prepare mathematics, science, or engineering professionals to become NSF Teaching Fellows, and to recruit existing teachers to become NSF Master Teaching Fellows. Requires Teaching Fellows and Master Teacher Fellows to serve as a mathematics or science teacher for four years and five years, respectively, in an elementary or secondary school served by a high-need LEA. Requires a 50% matching funds requirement from non-federal sources.

Increases Program scholarship amounts and sets stipend amounts.

Requires the Director: (1) to transmit to specified congressional committees a report on the effectiveness of the programs carried out under this section; and (2) in consultation with the Secretary of Education, to evaluate whether the scholarships, stipends, and fellowships authorized under this section have been effective in increasing the numbers of high-quality mathematics, and science teachers teaching in high-need LEAs and whether there continue to exist significant shortages of such teachers in such LEAs.

(Sec. 7031) Amends the Scientific and Advanced-Technology Act of 1992 to require the establishment of innovative partnership arrangements under the national advanced scientific and technical education program that encourage the participation of female, minority, and disabled students.

Requires the NSF Director to: (1) establish a program to encourage and make grants available to institutions of higher education that award associate degrees to recruit and train individuals from the fields of science, technology, engineering, and mathematics to mentor female, minority, and disabled students in order to assist such students in identifying, qualifying for, and entering higher-paying technical jobs in those fields; (2) make grants available to associate-degree-granting colleges to carry out such program; and (3) establish metrics to evaluate programs established by NSF for encouraging female, minority, and disabled students to study and prepare for careers in science, technology, engineering, and mathematics and report annually to Congress on evaluation results.

(Sec. 7032) Directs the NSF Director to arrange with the National Academy of Sciences (NAS) for a report to Congress about barriers to increasing the number of underrepresented minorities in science, technology, engineering, and mathematics fields and to identify strategies for bringing more underrepresented minorities into the science, technology, engineering, and mathematics workforce.

(Sec. 7033) Authorizes the NSF Director to establish a new program to award grants on a competitive, merit-reviewed basis to Hispanic-serving institutions to enhance the quality of undergraduate science, technology, engineering, and mathematics education at such institutions and to increase the retention and graduation rates of students pursuing associate's or baccalaureate degrees in science, technology, engineering, and mathematics.

Specifies that the grants awarded shall support: (1) activities to improve courses and curriculum in science, technology, engineering, and mathematics; (2) faculty development; (3) stipends for undergraduate students participating in research; and (4) other activities consistent with the grant program authorized by this section, as determined by the Director.

States that funding for instrumentation is an allowed use of grants awarded under this section.

(Sec. 7034) Requires the NSF Director to establish a clearinghouse, in collaboration with four-year institutions of higher education, industries, and federal agencies that employ science-trained personnel, to share program elements used in successful professional science master's degree programs and other advanced degree programs related to science, technology, engineering, and mathematics. Requires the Director to award grants to institutions of higher education to facilitate their creation or improvement of professional science master's degree programs that may include linkages between institutions of higher education and industries that employ science-trained personnel, with an emphasis on practical training and preparation for the workforce in high-need fields. Allows the Director to award up to 200 of such grants, which shall be for a three-year period, with one authorized renewal for an additional two-year period. Requires the Director to evaluate the programs and report evaluation results to Congress.

(Sec. 7035) Expresses the sense of Congress that institutions of higher education receiving awards under the NSF Integrative Graduate Education and Research Traineeship program should, among the activities supported under these awards, train graduate students in the communication of the substance and importance of their research to nonscientist audiences. Requires the NSF Director to transmit a report describing . such training programs provided to graduate students who participated in the program. Requires that such report include data on the number of graduate students trained and a description of the types of activities funded.

(Sec. 7036) Sets minimum and maximum amounts of awards under the Major Research Instrumentation program.

Permits, in addition to the acquisition of instrumentation and equipment, funds made available by awards under the Major Research Instrumentation program to be used to support the operations and maintenance of such instrumentation and equipment.

Requires an institution of higher education receiving an award under such program to provide at least 30% of the cost from private or non-federal sources. Exempts institutions of higher education that are not Ph.D.-granting institutions from such cost sharing requirement and allows the NSF Director to reduce or waive such requirement for: (1) certain institutions that are not ranked among the top 100 institutions receiving federal R&D funding; and (2) consortia of institutions of higher education that include at least one institution that is not a Ph.D.-granting institution.

(Sec. 7037) Revises the selection process for awards that require the submission of preproposals and that also limit the number of preproposals. Requires the National Science Board to: (1) assess the effects on institutions of higher education of NSF policies regarding the imposition of limitations on the number of proposals that may be submitted by a single institution for programs supported by NSF; (2) determine whether current policies are well justified and appropriate for the types of programs that limit the number of proposal submissions; and (3) summarize in a report the Board's findings and any recommendations regarding changes to the current policy on the restriction of proposal submissions.

Title VIII: General Provisions

(Sec. 8001) Directs the Secretary of Commerce, acting through the Director of the Bureau of Economic Analysis, not later than January 31, 2008, to report to Congress on the feasibility,

annual cost, and potential benefits of a program to collect and study data relating to the export and import of services.

(Sec. 8002) Expresses the sense of the Senate that the Securities and Exchange Commission (SEC) and the Public Company Accounting Oversight Board should complete promulgation of the final rules implementing section 404 of the Sarbanes-Oxley Act of 2002 (concerning auditing standards and their effect on small and mid-sized businesses).

(Sec. 8003) Directs the Comptroller General, not later than three years after enactment of this act, to submit a report to Congress that (1) assesses a representative sample of the new or expanded programs and activities required to be carried out under this act; and (2) includes recommendations as the Comptroller General determines are appropriate to ensure effectiveness of, or improvements to, the programs and activities, including termination of programs or activities.

(Sec. 8004) Expresses the sense of the Senate that federal funds should not be provided to any organization or entity that advocates against a U.S. tax policy that is internationally competitive.

(Sec. 8005) Directs the Secretary of Education to arrange with the NAS to conduct a study and provide a report to such Secretary, the Secretary of Commerce, and Congress which shall consider: (1) the mechanisms and supports needed for an institution of higher education or nonprofit to develop and maintain a program to provide free access to online educational content as part of a degree program, especially in science, technology, engineering, mathematics, or foreign languages, without using federal funds, including funds provided under title IV of the Higher Education Act of 1965; and (2) whether such a program could be developed and managed by such institution or nonprofit and sustained through private funding. Authorizes appropriations.

(Sec. 8006) Expresses the sense of the Senate that (1) government policies of the U.S. government relating to deemed exports should safeguard US national security and protect fundamental research; (2) the Department of Commerce has established the Deemed Export Advisory Committee to develop recommendations for improving current controls on deemed exports; and (3) the President and Congress should consider the Committee's recommendations in the development and implementation of export control policies.

(Sec. 8007) Expresses the sense of the Senate that (1) Congress, the President, regulators, industry leaders, and other stakeholders should take necessary steps to reclaim the preeminent U.S. position in the global financial services marketplace; (2) federal and state financial regulatory agencies should take certain steps to avoid adverse consequences on innovation with respect to financial products and services, and regulatory costs that are disproportionate to their benefits; and (3) Congress should exercise vigorous oversight over federal regulatory and statutory requirements affecting the financial services industry and consumers.

(Sec. 8008) Prohibits a grant or contract funded by amounts authorized by this act from being used for defraying the costs of a banquet or conference that is not directly and programmatically related to the purpose for which the grant or contract was awarded. Requires: (1) reporting to the appropriate department, administration, or foundation of the records of total costs related to, and justification for, all banquets and conferences; and (2) such department, administration, or foundation to make such records available to the public not later than 60 days after their receipt.

Requires any person awarded a grant or contract funded by such amounts to submit a statement to the Secretary of Commerce, the Secretary of Energy, the Secretary of Education, the Administrator, or the Director, as appropriate, certifying that no funds derived from the grant or contract will be made available through a subcontract or in any other manner to another person who has a financial interest or other conflict of interest in the person awarded the grant or contract, unless such conflict is previously disclosed and approved in the process of entering into a contract or awarding a grant. Provides for the appropriate Secretary, Administrator, or Director to make all documents received that relate to the certification available to the public.

Makes such amendments effective 360 days after enactment of this act. Bars such amendments from being applicable to grants or contracts authorized under sections 6201 and 6203 of this act.

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