



America COMPETES Reauthorization Act of 2010 (H.R. 5116) and the America COMPETES Act (P.L. 110-69): Selected Policy Issues

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Summary

On August 9, 2007, President George W. Bush signed the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act (P.L. 110-69) into law. The law responded to concerns about long-term U.S. economic competitiveness and innovative capacity by authorizing increased investments in science, technology, engineering, and mathematics (STEM) education and federal research in the physical sciences and engineering. Statutory authorities for certain America COMPETES Act provisions expire in 2010 and work on reauthorization has begun in both chambers of Congress. On May 12 and 13, 2010, the House debated the America COMPETES Reauthorization Act of 2010 (H.R. 5116), voted on a series of amendments, and voted to recommit the bill to committee. Further House action on the measure was postponed immediately after the motion to recommit passed and the bill was eventually pulled from consideration. Similar legislation has not been introduced in the Senate yet.

H.R. 5116 builds upon, and differs from, P.L. 110-69. Among H.R. 5116's many provisions and titles, it augments and amends P.L. 110-69's provisions in STEM education and federal research in the physical sciences and engineering. H.R. 5116 includes new provisions that seek to increase coordination among federal STEM education programs and that seek to improve STEM teaching and learning in higher education. It would also increase authorizations for the National Science Foundation, National Institute of Standards and Technology laboratories, and Department of Energy Office of Science for a period of five years; and would make program changes that seek to provide for high-risk, high-reward research, and increased collaboration and commercialization.

H.R. 5116 would also expand provisions of P.L. 110-69 that sought to increase the participation of underrepresented populations in STEM education and employment, and would reauthorize the National Nanotechnology Initiative and Networking and Information Technology Research and Development program, two federal multi-agency R&D initiatives.

In both the debate about H.R. 5116 and evaluation of P.L. 110-69 critics have raised concerns about appropriations. They argue the bill is fiscally unsustainable in the current economic and budgetary environment. Supporters contend existing weaknesses in STEM education and federal research in the physical sciences and engineering threaten the fundamental underpinnings of the economy and therefore justify national investment even in an era of fiscal constraint.

This report provides background information on P.L. 110-69 and H.R. 5116 and analyzes four policy issues addressed by both measures: (1) STEM Education, (2) Federal Research Programs and Activities, (3) Broadening Participation, and (4) Funding. It also discusses selected policy concerns identified in the debate about U.S. competitiveness and describes how H.R. 5116 responds to those concerns. It contains a description of federal multi-agency research and development initiatives that are included in H.R. 5116. This report does not attempt to address all provisions of H.R. 5116 or to project likely outcomes from its provisions.

Contents

Introduction	1
The America COMPETES Act (P.L. 110-69)	2
The America COMPETES Reauthorization Act of 2010 (H.R. 5116).....	3
Selected Policy Issues	3
STEM Education.....	4
STEM Education Policy Issues and H.R. 5116	5
Federal Research Programs and Activities	5
Federal Research Programs and Activities Policy Issues and H.R. 5116.....	6
Broadening Participation.....	7
Broadening Participation Policy Issues and H.R. 5116.....	8
Funding	9
Funding Policy Issues and H.R. 5116	10
Federal Multi-Agency Research and Development Initiatives	11
National Nanotechnology Initiative Amendments Act of 2010.....	12
Networking and Information Technology Research and Development Program	13

Contacts

Author Contact Information	14
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Introduction

On August 9, 2007, President George W. Bush signed the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act (P.L. 110-69) into law. The act primarily responded to concerns about long-term U.S. economic competitiveness and innovative capacity by, among other things, authorizing increased investments in science, technology, engineering, and mathematics (STEM) education and in federal research in the physical sciences and engineering.

Statutory authorities for certain America COMPETES Act provisions expire in 2010. Committees in the House and Senate have begun the process of re-examining the policy rationale behind the law and determining whether to continue, alter, add to, or terminate its various provisions. The Chairman of the House Committee on Science and Technology, Representative Bart Gordon, has announced his intention to bring a reauthorization measure “through the House before the Memorial Day district work period.”¹ To that end, he introduced legislation reauthorizing the law on April 22, 2010. The America COMPETES Reauthorization Act of 2010 (H.R. 5116) was referred to the House Committee on Science and Technology, from which it was ordered reported as amended by a vote of 29-8 on April 28, 2010.

On Tuesday, May 8, 2010, the House Committee on Rules met and reported H.Res. 1344, which provided a structured rule for, and amendments to, H.R. 5116. The bill was put on the floor calendar for further consideration. On Wednesday, May 12, 2010, H.R. 5116 was brought to the floor and a series of amendments were voted on during that day and the following morning. On Thursday, May 13, 2010, the House dispensed with amendments, after which members voted to recommit the measure to the House Committee on Science and Technology with instructions. During debate about the motion to recommit, opponents of the bill raised concerns about the cost of the bill, the addition of new programs, and the length of the authorization period. Additional concerns were raised about the misuse of federal computers for pornographic purposes by executive branch employees, military recruitment on college campuses, and the bill’s disabled veterans provisions. The House postponed further action on H.R. 5116 immediately after the motion to recommit passed. Representative Gordon had the measure pulled from consideration on May 13, 2010.

This report provides background information on P.L. 110-69 and H.R. 5116 and analyzes four policy issues addressed by both measures: (1) STEM Education, (2) Federal Research Programs and Activities, (3) Broadening Participation, and (4) Funding. It also discusses selected policy concerns identified in the debate about U.S. competitiveness and describes how H.R. 5116 responds to those concerns. It contains a description of federal multi-agency research and development initiatives that are included in H.R. 5116. This report does not attempt to address all provisions of H.R. 5116 or to project likely outcomes from its provisions.

¹ House Committee on Science and Technology, “Chairman Gordon Introduces COMPETES,” Press Release, April 22, 2010, <http://science.house.gov/press/prarticle.aspx?newsid=2806>.

The America COMPETES Act (P.L. 110-69)

At the time the America COMPETES Act was passed and signed into law, many analysts believed additional federal investment in basic research and STEM education would help counter perceived threats to long-term U.S. economic competitiveness. In the two years leading up to the bill's introduction, at least six major reports were published asserting this position in whole or part. A broad consensus developed among research, industry, and education stakeholders in support of a national response.² In August 2007 Congress passed the America COMPETES Act and President George W. Bush signed the measure, which became P.L. 110-69.

P.L. 110-69 was designed to “invest in innovation through research and development, and to improve the competitiveness of the United States.”³ In total, the America COMPETES Act authorized \$33.6 billion in appropriations between FY2008 and FY2010 for federal programs and activities. It has eight titles containing more than 100 sections that direct specific programs and policies at seven federal offices and agencies: (1) Office of Science and Technology Policy (OSTP), (2) National Aeronautics and Space Administration (NASA), (3) National Institute of Standards and Technology (NIST), (4) National Oceanic and Atmospheric Administration (NOAA), (5) Department of Energy (DOE), (6) Department of Education (ED), and (7) National Science Foundation (NSF).

The law primarily addressed two broad policy areas: federal programs in STEM education and federal research activities in the physical sciences and engineering. Within these policy areas the law established new programs, such as the Math Now program at ED, and reauthorized existing programs, such as the Manufacturing Extension Partnership program at NIST. The law also increased the appropriations authorizations of certain programs and activities. The law's largest authorizations of appropriations were for NSF, NIST laboratories, and the DOE Office of Science.

Since its inception, P.L. 110-69 has not been fully funded. Some of the law's authorized programs and activities received no appropriated funding during the authorization period. Other programs and activities funded through the regular appropriations process received funding below authorized levels. Some programs and activities that did not receive funding during the regular appropriations process, or that received funding below authorized levels, were subsequently funded through supplemental appropriations legislation.⁴

² For more information, see The Education Commission of the States, *Keeping America Competitive: Five Strategies To Improve Mathematics and Science Education*, July 2005; The Association of American Universities, *National Defense Education and Innovation Initiative, Meeting America's Economic and Security Challenges in the 21st Century*, January 2006; The National Academy of Sciences, Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, February 2006; The National Summit on Competitiveness, *Statement of the National Summit on Competitiveness: Investing in U.S. Innovation*, December 2005; The Business Roundtable, *Tapping America's Potential: The Education for Innovation Initiative*, July 2005; and the Center for Strategic and International Studies, *Waiting for Sputnik*, 2005.

³ America COMPETES Act, P.L. 110-69, Purpose.

⁴ For more information, see CRS Report R40519, *America COMPETES Act and the FY2010 Budget*, by John F. Sargent Jr.; and CRS Report RL34328, *America COMPETES Act: Programs, Funding, and Selected Issues*, by Deborah D. Stine.

The America COMPETES Reauthorization Act of 2010 (H.R. 5116)

The America COMPETES Reauthorization Act of 2010 (H.R. 5116) is a bill designed to “invest in innovation through research and development, improve the competitiveness of the United States, and for other purposes.”⁵ It has seven titles, three of which organize programs and activities by agency (NSF, NIST, DOE) and four that organize programs and activities by policy area (“Science and Technology Policy,” “STEM Education,” “Innovation,” and “Miscellaneous”).

Together these titles seek to address many of the same broad challenges in STEM education and federal research in the physical sciences and engineering as the 2007 America COMPETES Act. H.R. 5116’s STEM education provisions, among other things, would create new programs and amend existing programs designed to increase collaboration between existing federal STEM education programs, improve STEM teaching and learning in higher education, and provide for STEM education research. H.R. 5116’s science and engineering research provisions, among other things, would continue previously established commitments to doubling the combined budgets of NSF, NIST laboratories, and DOE Office of Science. It would seek to encourage increased research collaboration and commercialization and to invest in high-risk, high-reward research. H.R. 5116 also contains provisions intended to broaden the STEM participation of underrepresented populations and would enact a variety of policy responses to identified achievement gaps in STEM education and STEM occupations.

H.R. 5116 also builds upon P.L. 110-69’s STEM education and research provisions by addressing new policy issues and approaches. These changes include the establishment of individual programs, such as the Federal Loan Guarantees for Innovative Technologies in Manufacturing program,⁶ and coordination of federal multi-agency research and development initiatives, like the National Nanotechnology Initiative and Networking and Information Technology Research and Development program.⁷

Selected Policy Issues

The following sections provide an analysis of selected provisions of P.L. 110-69 and H.R. 5116, organized by policy area. Policy areas covered in this report include STEM Education; Federal Research Programs and Activities; Broadening Participation; and Funding. These policy areas were selected because of their relevance to current and past congressional debate about the America COMPETES Act.

⁵ America COMPETES Reauthorization Act of 2010, H.R. 5116, Purpose.

⁶ H.R. 5116, Title V, Section 502.

⁷ For more information, see CRS Report RL34401, *The National Nanotechnology Initiative: Overview, Reauthorization, and Appropriations Issues*, by John F. Sargent Jr.; and CRS Report RL33586, *The Federal Networking and Information Technology Research and Development Program: Funding Issues and Activities*, by Patricia Moloney Figliola.

STEM Education

The America COMPETES Act provided new authorities, as well as reauthorized existing authorities, for federal STEM education programs, policies, and activities. New programs established by P.L. 110-69 included the Experiential-Based Learning Opportunities, Math Now, and Math Skills for Secondary Students programs.⁸ The law also authorized appropriations for existing federal activities including the Graduate Research Fellowship (GRF) program.

H.R. 5116 would amend some of P.L. 110-69's STEM education provisions to make operational changes to existing programs. For example, H.R. 5116 would repeal specific DOE STEM education programs and replace them with a general agency directive to conduct STEM education.⁹ Other provisions would amend graduate student support programs at NSF to provide for "equal treatment" of the Integrative Graduate Education and Research Traineeship (IGERT) and the GRF programs by linking changes in their funding rates.¹⁰

H.R. 5116 would also establish new programs, policies, and activities designed to increase collaboration in federal STEM education. Therefore, H.R. 5116 includes provisions that would attempt to improve enterprise-wide coordination of federal STEM education¹¹ and direct NSF, ED, and the National Institutes of Health to work together to identify grand challenges in education research.¹²

In addition to encouraging increased collaboration in federal STEM education programs, H.R. 5116 builds upon P.L. 110-69's STEM education provisions by amending and establishing new general statutory authorities for higher education programs. For example, H.R. 5116 would amend the National Science Foundation Authorization Act of 2002 (42 U.S.C. 1862n-6) to authorize the "development, implementation, and assessment of innovative, research-based approaches to transforming the teaching and learning of disciplinary or interdisciplinary STEM at the undergraduate level"¹³ and makes similar provisions for master's and doctoral-level STEM education.¹⁴ Another provision would create a postdoctoral fellowship program in STEM education research at NSF.¹⁵

H.R. 5116 does not address or support all of the STEM education provisions found in P.L. 110-69. For example, the bill does not reauthorize ED programs authorized by P.L. 110-69. H.R. 5116 also generally authorizes appropriations for NSF activities at the major account level (e.g., Research and Related Activities), rather than at the program level (e.g., IGERT and GRF) as

⁸ Some of the new STEM education programs established by P.L. 110-69 were not funded, including the Experiential-Based Learning Opportunities, Math Now, and Math Skills for Secondary Students programs. In contrast, the Teachers for a Competitive Tomorrow program at ED received appropriations every year during the law's authorization period.

⁹ H.R. 5116, Title III, Section 303.

¹⁰ H.R. 5116, Title II, Subtitle C, Section 241.

¹¹ H.R. 5116, Title III, Section 301.

¹² H.R. 5116, Title II, Subtitle C, Section 251.

¹³ H.R. 5116, Title II, Subtitle C, Section 248.

¹⁴ H.R. 5116, Title II, Subtitle C, Section 249.

¹⁵ H.R. 5116, Title II, Subtitle C, Section 242.

authorized by P.L. 110-69.¹⁶ H.R. 5116 would also repeal some programs authorized by P.L. 110-69, such as the Professional Science Master's program.¹⁷

STEM Education Policy Issues and H.R. 5116

STEM education advocates have argued that perceived problems in student achievement means the United States may lose a critical comparative advantage in the global competition for high-wage, high-tech jobs: our STEM labor supply.¹⁸ Critics of this assertion claim little evidence exists of an overall shortage in the U.S. STEM workforce and that demand-side factors, such as the undesirability of certain STEM jobs, create the perception of shortages.¹⁹ Nevertheless, many advocates remain concerned about the impact of global shifts in education attainment and demographic changes in the composition of the U.S. workforce on the U.S. economy over the long term.²⁰

General concerns about U.S. student mathematics and science performance have fueled specific policy debates in Congress.²¹ Questions have been raised about the best way to ensure high-quality STEM teaching and learning across all education segments, about governance of federal STEM education programs, about the health and functioning of the high-technology economy and demand for STEM workers, about the lack of definitive research on key STEM education questions, and about the nation's ability to replicate and scale promising practices.

H.R. 5116 responds to these concerns in two primary ways. It creates new programs or amends existing programs designed to increase collaboration between existing federal STEM education programs, and improve STEM teaching and learning in higher education. It also provides for increased research on STEM education, among other things.

Federal Research Programs and Activities

P.L. 110-69 both authorized and established new federal research and development activities and programs, including the Manufacturing Extension Partnership (MEP) program, Technology Innovation Program (TIP), and the Advanced Research Projects Agency-Energy (ARPA-E). H.R. 5116 would make operational, programmatic, or appropriations authorizations changes to these three programs. The MEP provisions, in part, would allow MEP centers to assist small-and medium-sized manufacturers with energy efficiency and waste reduction.²² The TIP provisions would reauthorize the TIP Advisory Board.²³ The ARPA-E provisions would provide FY2011-

¹⁶ H.R. 5116, Title II, Subtitle A, Section 212.

¹⁷ H.R. 5116, Title II, Subtitle C, Section 249(e).

¹⁸ For example, see Association for Career and Technical Education, *Issue Brief: CTE's Role in Science, Technology, Engineering, and Math*, June 2009, http://www.acteonline.org/uploadedFiles/Publications_and_Online_Media/files/STEM_Issue_Brief.pdf.

¹⁹ For example, see Beryl Lieff Benderly, "Does the U.S. Produce Too Many Scientists?" *Scientific American*, February 22, 2010, <http://www.scientificamerican.com/article.cfm?id=does-the-us-produce-too-m>.

²⁰ For example, see Thomas J. Donohue, president and CEO, U.S. Chamber of Commerce, Testimony before the House Committee on Science and Technology, January 20, 2010.

²¹ For more information, see CRS Report 98-871, *Science, Engineering, and Mathematics Education: Status and Issues*, by Christine M. Matthews.

²² H.R. 5116, Title IV, Section 406.

²³ H.R. 5116, Title IV, Section 409.

FY2015 appropriations authorization for the program and would make program changes. These changes are designed to allow for a more commercial and applied focus in research, establish a permanent staff, and create a fellowship program for early-career and senior scientists.²⁴

In addition to these changes, H.R. 5116 includes provisions to encourage collaboration between research entities, promote commercialization, and support high-risk, high-reward research. Examples of these types of provisions include, but are not limited to, the following:

- *Collaboration*—H.R. 5116 would provide statutory authority for two existing DOE initiatives: (1) Energy Frontier Research Centers²⁵ and (2) Energy Innovation Hubs,²⁶ both of which provide for collaborative energy research. The bill also seeks to encourage regional economic collaboration through the Regional Innovation Program.²⁷
- *Commercialization*—H.R. 5116 directs the Department of Commerce to establish an Office of Innovation and Entrepreneurship to foster innovation and commercialization of new technologies,²⁸ and instructs NSF to award grants to institutions of higher education to establish and expand partnerships with private-sector entities to promote innovation and increase the economic and social impact of research.²⁹
- *High-Risk, High-Reward Research*—H.R. 5116 establishes a policy requiring NSF to “use at least 5 percent of its research budget to fund high-risk, high-reward basic research proposals.”³⁰

Federal Research Programs and Activities Policy Issues and H.R. 5116

In its 2006 publication, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, the National Academies called for a 10% annual increase in federal support of long-term basic research over seven years.³¹ These investments were necessary, the National Academies argued, because federal funding of basic research in the physical sciences and engineering had stagnated for many years. Additionally, they asserted that in a stagnating budgetary environment high-risk, high-reward research tended to be overlooked. Although some critics have argued that the private-sector does fund basic research, and that it funds more commercially-viable research,³² many advocates remain concerned that U.S. competitiveness will be negatively affected if the federal government does not increase investments in basic research.³³

²⁴ H.R. 5116, Title VI, Subtitle B, Section 622.

²⁵ H.R. 5116, Title VI, Subtitle A, Section 604. Energy Frontier Research Centers are to conduct fundamental research focusing on grand challenges identified in DOE and National Academy of Engineering reports.

²⁶ H.R. 5116, Title VI, Subtitle C, Section 632. Energy Innovation Hubs provide for geographically clustered, multi-party, multi-disciplinary, collaborative research in fields not served by the private sector.

²⁷ H.R. 5116, Title V, Section 503.

²⁸ H.R. 5116, Title V, Section 501.

²⁹ H.R. 5116, Title II, Subtitle C, Section 227.

³⁰ H.R. 5116, Title II, Subtitle C, Section 221.

³¹ The National Academy of Sciences, Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, Washington, DC: National Academies Press, February 2006.

³² For example, see Terence Kealey, “End Government Science Funding,” *Cato.org*, April 11, 1997, (continued...)

Congress faces a variety of policy issues related to research funding. These include (1) whether to increase, decrease, or maintain federal spending on research; (2) whether to increase, decrease, or maintain federal spending in specific areas, such as energy, nanotechnology, or manufacturing; (3) whether to invest directly in research at federal agencies or subsidize research in industry, academia, or the non-profit sector; (4) whether to increase, decrease, or maintain agency research budgets within the current federal portfolio; (5) whether and how to balance relative federal investment in basic and applied research; and (6) what goals, if any, Congress has for the products of research.

H.R. 5116 would address some of these questions by authorizing increased appropriations for federal spending on research in the physical sciences and engineering, and by encouraging increased collaboration, commercialization, and high-risk, high-reward research. It would make investments primarily in research funding at federal agencies, but would support research conducted by government, universities, and industry. H.R. 5116 would target funds to primarily three agencies within the federal portfolio: NSF, NIST, and DOE. Although the bill would provide mostly for basic research, it also incorporates new provisions for commercialization and applied research not present in P.L. 110-69.

Proposed Changes to HBCU-UP, Stokes, and TCUP in H.R. 5116³⁵

The Obama Administration's proposed FY2011 budget would consolidate several NSF undergraduate programs, including the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), the Louis Stokes Alliances for Minority Participation Program (Stokes), and the Tribal Colleges and Universities Program (TCUP). H.R. 5116 would maintain these as separate programs through September 30, 2011, and direct NSF to undertake a number of planning and assessment activities before consolidation could occur.

Broadening Participation

P.L. 110-69 was intended to broaden participation and increase the participation rates of underrepresented populations in STEM education and achievement through direct and indirect means. One example of a direct approach to broadening participation is the Teachers for a Competitive Tomorrow program, which includes provisions that require institutional applicants to describe how their proposals will encourage participation by underrepresented groups. An example of an indirect approach to broadening participation is the program changes P.L. 110-69 makes to Advanced Placement (AP) programs, including expanding the statute to include International Baccalaureate programs.³⁴

(...continued)

http://www.cato.org/pub_display.php?pub_id=6168.

³³ For example, see John Engler, president and CEO, National Association of Manufacturers, Testimony before the House Committee on Science and Technology, January 20, 2010.

³⁴ Advocacy groups have argued that greater access to AP programs and test fee subsidies increase AP program participation by underrepresented minorities.

H.R. 5116 would build upon P.L. 110-69 with a number of new provisions that seek to broaden participation in STEM education and STEM fields by underrepresented populations. Among these are provisions directing NSF to examine grant proposals for their potential to increase the participation of women and underrepresented minorities in STEM,³⁶ and directing NSF to train staff and merit review panelists on effective methods to broaden participation.³⁷ H.R. 5116 would also strengthen the position of minority-serving institutions in research partnerships with other institutions by specifying that some portion of research funds must be awarded directly to the minority-serving institution.³⁸ It would also broaden the definition of minority-serving institutions to include those that serve large numbers of students with disabilities.³⁹

The bill would also amend some provisions of P.L. 110-69 that sought to increase the participation of underrepresented populations in STEM. For example, it would replace a more narrowly drafted provision of the America COMPETES Act that authorized a specific DOE program designed to encourage underrepresented minorities to pursue STEM careers⁴⁰ with more comprehensive language requiring outreach and consideration of students from underrepresented populations in agency STEM education efforts.⁴¹

Broadening Participation Policy Issues and H.R. 5116

Experts who have analyzed education and workforce participation indicators have highlighted racial, ethnic, and gender gaps in STEM achievement.⁴² These gaps, in combination with shifts in the U.S. demographic profile, have led some observers to predict that underachievement in STEM by historically underrepresented populations could have serious consequences for the future U.S. workforce, national economy, and competitiveness.⁴³

Most advocates and experts agree that racial, ethnic, and gender achievement gaps exist, and they have suggested a wide range of causes and solutions for narrowing the gap.⁴⁴ In recent congressional hearings on the topic of broadening participation in STEM, one expert testified that lack of access to Advanced Placement courses, schools with poor facilities and teachers, students who leave high school without college prerequisites, and a lack of expectations for students are factors contributing to the gap.⁴⁵ Another witness summarized recent research on participation

(...continued)

³⁵ H.R. 5116, Title II, Subtitle C, Section 250.

³⁶ H.R. 5116, Title II, Subtitle C, Section 214.

³⁷ H.R. 5116, Title II, Subtitle C, Section 247.

³⁸ H.R. 5116, Title II, Subtitle C, Section 224.

³⁹ H.R. 5116, Title II, Subtitle C, Section 244.

⁴⁰ P.L. 110-69, Title V, Section 5003 (d).

⁴¹ H.R. 5116, Title III, Section 303.

⁴² For example, see National Science Foundation, *Science and Engineering Indicators: 2010*, Arlington, VA: National Science Foundation (NSB 10-01).

⁴³ For example, see Ronald J. Burke and Mary C. Mattis, eds., *Women and Minorities in Science, Technology and Engineering: Upping the Numbers*, Northampton, MA: Edward Elgar Publishing, Inc, 2007.

⁴⁴ The following sources in this paragraph provide the viewpoints of the annotated advocates and experts listed below. It is important to note that the *Rising Above the Gathering Storm* report examined these issues in broader context.

⁴⁵ Shirley Malcom, head of education and human resources programs, American Association for the Advancement of Science, Testimony before the House Committee on Science and Technology, Subcommittee on Research and Science Education, March 16, 2010.

and concluded “... that racial stigma and discrimination create significant barriers to the participation of underrepresented racial-ethnic groups in STEM.”⁴⁶ Other experts have found that achievement gaps can be attributed at least in part to the effects of peers and school quality and suggest policies to expand the pool of potential teachers by relaxing licensing requirements for new teachers, increasing teacher salaries, and improving working conditions.⁴⁷ Still others contend that the best way to increase the number of U.S. students who are prepared to enter STEM fields is to provide for general K-12 education reform, including accountability, school choice, and performance pay at the state and local level.⁴⁸

H.R. 5116 adopts a variety of policy responses to attempt to close achievement gaps and broaden the participation of underrepresented populations in STEM education and STEM fields. For example, it includes provisions that would require NSF to train staff and merit review panelists in methods that seek to counter the effects of implicit bias,⁴⁹ and that would support minority-serving institutions of higher education.⁵⁰ It also contains provisions directing OSTP to offer workshops on ways to minimize the effects of gender bias in the evaluation of federal research grants, among other things.⁵¹

Funding

P.L. 110-69 set a pace for doubling the aggregate combined budgets of NSF, NIST laboratories, and DOE Office of Science over a period of seven years, and authorized increases in appropriations for several STEM education programs and activities. The doubling process is underway, though with a later start and over a longer term than the law originally envisioned.⁵² However, actual appropriations for P.L. 110-69’s STEM education provisions have not met authorized levels in some cases.⁵³

H.R. 5116 extends P.L. 110-69’s increased support for federal research in the physical sciences and engineering. Its appropriations authorizations are in line with a ten-year doubling path for NSF, NIST laboratories, and the DOE Office of Science.⁵⁴ It would also reauthorize

⁴⁶ Alicia C. Dowd, associate professor and co-director, Center for Urban Education, Rossier School of Education, University of Southern California, Testimony before the House Committee on Science and Technology, Subcommittee on Research and Science Education, March 16, 2010.

⁴⁷ For example, see Erik A. Hanushek and Steve G. Rivkin, “Harming the Best: How Schools Affect the Black-White Achievement Gap,” *Journal of Policy Analysis and Management*, 28(3), Summer 2009, pp. 336-393, http://edpro.stanford.edu/hanushek/files_det.asp?FileId=243.

⁴⁸ For example, see Dan Lips and Jena Baker McNeill, *Background on Education: A New Approach to Improving Science, Technology, Engineering, and Math Education*, Heritage Foundation, April 15, 2009, <http://www.heritage.org/Research/Reports/2009/04/A-New-Approach-to-Improving-Science-Technology-Engineering-and-Math-Education>; and Dan Lips, *EDUCATION NOTEBOOK: Improving Educational Opportunities for Hispanic Children*, Heritage Foundation, March 23, 2009, <http://www.heritage.org/Research/Education-Notebook/Improving-Educational-Opportunities-for-Hispanic-Children?renderforprint=1>.

⁴⁹ H.R. 5116, Title II, Subtitle C, Section 247.

⁵⁰ H.R. 5116, Title II, Subtitle B, Section 224.

⁵¹ H.R. 5116, Title I, Subtitle C, Section 124.

⁵² The Obama Administration’s FY2011 budget is consistent with a 10-year doubling path.

⁵³ CRS Report R40519, *America COMPETES Act and the FY2010 Budget*, by John F. Sargent Jr.

⁵⁴ H.R. 5116, Title II, Subtitle A, Section 212; H.R. 5116, Title IV, Section 402; and H.R. 5116, Title VI, Subtitle A, Section 611; respectively.

appropriations for ARPA-E.⁵⁵ Authorizations for NSF, NIST, and DOE, as well as those for ARPA-E, would be provided through FY2015. The original America COMPETES Act provided authorization of appropriations from FY2008 through FY2010.

H.R. 5116 does not address many of the STEM education programs that were authorized by P.L. 110-69, including and some that received specified appropriations (e.g., Teachers for a Competitive Tomorrow) and some that did not (e.g., Math Now, Pilot Program of Grants to Specialty Schools for Science and Mathematics, and Summer Institutes). H.R. 5116 does not reauthorize Department of Education (ED) STEM education programs in P.L. 110-69.

H.R. 5116 adds new appropriations authorizations for existing and new federal research and STEM education activities. For example, the existing Energy Innovation Hubs program at DOE would receive appropriations authorizations.⁵⁶ The bill would also authorize, among other things, appropriations for a federal loan guarantee program for small- and mid-sized manufacturers that produce or use innovative technologies, and appropriations for amended STEM talent expansion programs at DOE.⁵⁷

Funding Policy Issues and H.R. 5116

The 2006 National Academies report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* asserted that increased federal investment in STEM education and basic research were necessary for maintaining U.S. competitiveness.⁵⁸ To that end, the report recommended increasing federal investment in long-term basic research by 10% annually over seven years and encouraged large federal investments in STEM education, including funding 5,000 new graduate fellowships each year. Criticism of this approach primarily comes from those who prefer alternative policies, such as tax and regulatory reforms in support of the private sector, or who have concerns about federal spending in general.⁵⁹ Supporters argue that the private sector has neither the capacity nor the will to fund basic research lacking a clear commercial benefit, and that investigator-driven basic research has resulted in many important social and economic benefits.

Funding questions have generated some of the more contentious America COMPETES Act-related debates. Stakeholders in the education and research communities have criticized the implementation of P.L. 110-69 both for what was not funded and for what was. Some educators have called the law's education provisions "unfulfilled promises" because programs like Math Now and Math Skills for Secondary Students were never funded.⁶⁰ On the other hand, some experts have argued against the way research was funded in P.L. 110-69.⁶¹ They contend the

⁵⁵ H.R. 5116, Title VI, Subtitle B, Section 622.

⁵⁶ H.R. 5116, Title VI, Subtitle C, Section 632.

⁵⁷ H.R. 5116, Title V, Section 502 and H.R. 5116, Title III, Section 303.

⁵⁸ The National Academy of Sciences, Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, February 2006.

⁵⁹ For example, see Wayne Crews, "The Future of Manufacturing: What is the Role of the Federal Government in Supporting Innovation by U.S. Manufacturers," Testimony before the House Committee on Science and Technology, March 17, 2010.

⁶⁰ Erik Roblolen, "Many Authorized STEM Education Programs Fail to Get Funding," *Education Week*, February, 23, 2010, http://www.edweek.org/ew/articles/2010/02/24/22stem_ep.h29.html.

⁶¹ Brain Kahin and Christopher T. Hill, "United States: The Need for Continuity," *Issues in Science and Technology*, (continued...)

doubling path for increases in research in the physical sciences and engineering contributes to a boom and bust approach to research expenditures that could have negative consequences for research. Finally, in both the 2010 reauthorization and 2007 America COMPETES Act debates some legislators have voiced concerns about these policies in light of their fiscal impact on the national budget and federal spending.

Supporters of increased funding, on the other hand, argue existing weaknesses in STEM education and federal research threaten the fundamental underpinnings of the economy and therefore justify national investment even in an era of fiscal constraint.⁶² They assert that approximately half of U.S. long-term economic growth is related to the adoption and development of new technologies.⁶³ Some supporters also assert education achievement gaps between the United States and other nations, or innovation gains made by other countries, as long-term economic challenges requiring serious and sustained national investment and attention.⁶⁴

H.R. 5116 responds to various concerns about funding provisions by increasing both authorizations periods and authorizations levels for many research provisions. It does not renew authorizations for many of P.L. 110-69's STEM education programs, and eliminates others.

Federal Multi-Agency Research and Development Initiatives

Title I of H.R. 5116 contains provisions relating to coordination of federal multi-agency research and development (R&D) initiatives. While H.R. 5116 addresses several cross-cutting STEM education and science and engineering research initiatives, the National Nanotechnology Initiative (NNI) and the Networking and Information Technology Research and Development (NITRD) are two major programs that pre-date the America COMPETES Act and have distinct legislative histories. The following sections provide brief background on these initiatives. For more detailed analysis, see CRS Report RL34401, *The National Nanotechnology Initiative: Overview, Reauthorization, and Appropriations Issues*, by John F. Sargent Jr., and CRS Report RL33586, *The Federal Networking and Information Technology Research and Development Program: Funding Issues and Activities*, by Patricia Moloney Figliola.

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Spring 2010, <http://www.issues.org/26.3/kahin.html>.

⁶² For example, see Mark Muro, "America COMPETES: Vehicle for Innovating at Innovation," *The New Republic*, April 14, 2010, <http://www.tnr.com/blog/the-avenue/america-competes-vehicle-innovating-innovation>.

⁶³ For example, see House Committee on Science and Technology, *Legislation Advancing Innovation Clears Committee with Bipartisan Support*, Press Release, April 28, 2010, <http://science.house.gov/press/PRArticle.aspx?NewsID=2809>.

⁶⁴ For example, see Deborah Wince-Smith, "Testimony before the House Committee on Science and Technology, Reauthorization of the America COMPETES Act," testimony before the House Committee on Science and Technology, January 20, 2010.

National Nanotechnology Initiative Amendments Act of 2010

Nanotechnology⁶⁵ has been an issue of interest to Congress for a number of years. Since the launch of the U.S. National Nanotechnology Initiative (NNI) in FY2001, Congress has appropriated approximately \$12.4 billion for nanotechnology science, engineering, and technology. The development and application of nanotechnology across a wide array of products and industries holds the potential for significant economic and societal benefits. Proponents of the NNI assert that nanotechnology is one of the most important emerging and enabling technologies and that U.S. competitiveness, technological leadership, national security, and societal interests require an aggressive approach to the development and commercialization of nanotechnology. Opponents cite the potential for unanticipated effects as reason to move cautiously in the development, manufacture, and licensure of nanotechnology-based products.

Although the NNI has yielded scientific and engineering advances, as well as some nanotechnology products, capturing the anticipated widespread benefits of nanotechnology will likely require a variety of technical and policy challenges to be addressed. These challenges include environmental, health, and safety concerns and their implications for workplace, environmental, food, drug, and other regulations; development of standards and reference materials; development of new measurement methods and tools; and technology transfer to the private sector.

The National Nanotechnology Initiative Amendments Act of 2010⁶⁶ would amend the 21st Century Nanotechnology Research and Development Act (P.L. 108-153) which Congress enacted in 2003 to provide a legislative foundation for some of the activities of the National Nanotechnology Initiative (NNI). These provisions are nearly identical to those of H.R. 554, the National Nanotechnology Initiative Amendments Act of 2009, which passed the House in February 2009.⁶⁷ This bill was referred to the Senate Committee on Commerce, Science, and Transportation; no further action has been taken.

In particular, this subtitle seeks to address nanotechnology environmental, health, and safety concerns by including, among other things, a requirement to designate an associate director of the Office of Science and Technology Policy to serve as Coordinator for Societal Dimensions of Nanotechnology;⁶⁸ authorizes funding for a triennial review of the NNI by the National Research Council; directs broader agency support for the development of nanotechnology standards; expands efforts focused on technology transfer, including prototyping, collaboration with industry, and coordination with state nanotechnology initiatives; and emphasizes agency support for research in areas of national importance and for nanomanufacturing.

⁶⁵ The National Science and Technology Council defines nanotechnology as “the understanding and control of matter at dimensions between 1 and 100 nanometers, where unique phenomena enable novel applications.... Unusual physical, chemical, and biological properties can emerge in materials at the nanoscale. These properties differ in important ways from the properties of bulk materials and single atoms or molecules.”

⁶⁶ H.R. 5116, Title I, Subtitle A.

⁶⁷ H.R. 5116 changes the name of the act from the “National Nanotechnology Initiative Amendments Act of 2009,” to “National Nanotechnology Initiative Amendments Act of 2010,” and removes the term “interdisciplinary” from a provision establishing “green nanotechnology” research centers.

⁶⁸ The Office of Science and Technology Policy is a part of the Executive Office of the President.

Networking and Information Technology Research and Development Program⁶⁹

In the early 1990s, Congress recognized that several federal agencies had ongoing high-performance computing programs, but no central coordinating body existed to ensure long-term coordination and planning. To provide such a framework, Congress created the High-Performance Computing and Communications (HPCC) Program.⁷⁰ The HPCC Program has evolved over time and is now called the Networking and Information Technology Research and Development (NITRD) Program, to better reflect its expanded mission.

The federal government has long played a key role in the country's information technology (IT) research and development (R&D) activities. The government's support of IT R&D began because of its interest in supporting the development of computers that would be capable of addressing the complex problems and issues the government needed to solve and study. This complexity requires there be adequate coordination to ensure the government's evolving needs (e.g., global competition, homeland security) will continue to be met in the most effective manner possible.

The Networking and Information Technology Research and Development Act of 2010⁷¹ would amend the High-Performance Computing and Communications Act of 1991 (15 U.S.C. 5511) to instruct the participating agencies to conduct regular assessments of the program's responsiveness to current needs and give flexibility to the National Coordination Office (NCO) of the NITRD to restructure the program to respond to those needs. The act specifically states that the participating agencies "ensure that the Program includes large-scale, long-term, interdisciplinary research and development activities."

The act instructs the participating agencies, working through the National Science and Technology Council and with the assistance of the NCO, to develop a five-year strategic plan to guide NITRD activities. The plan must specify "near-term and long-term objectives for the Program, the anticipated time frame for achieving the near-term objectives, and the metrics to be used for assessing progress toward the objectives."⁷²

In particular, the strategic plan should include a path forward to fostering the transfer of R&D results into new technologies and applications for the benefit of society; encouraging and supporting mechanisms for interdisciplinary R&D in networking and information technology; addressing long-term challenges of national importance for which solutions require large-scale, long-term, interdisciplinary research and development; emphasizing innovative and high-risk projects having the potential for substantial societal returns on the research investment; strengthening all levels of relevant technology education; and attracting more women and underrepresented minorities to pursue postsecondary degrees in networking and information technology. The plan is to be submitted to the Committee on Commerce, Science, and

⁶⁹ This subtitle may be cited as the 'Networking and Information Technology Research and Development Act of 2010.'

⁷⁰ The High-Performance Computing and Communications Program Act of 1991 (P.L. 102-194). In conjunction with the passage of the act, the White House Office of Science and Technology Policy (OSTP) released Grand Challenges: High-Performance Computing and Communications. That document outlined a research and development (R&D) strategy for high-performance computing and a framework for a multiagency program—the HPCC Program.

⁷¹ H.R. 5116, Title I, Subtitle B.

⁷² H.R. 5116, Title I, Subtitle B, Section 102.

Transportation of the Senate and the Committee on Science and Technology of the House of Representatives.

Finally, the act requires that the Director of the NCO convene a task force composed of participants from institutions of higher education, federal laboratories, and industry, to explore mechanisms for developing cyber-physical systems.⁷³ Cyber-physical systems are expected to be the backbone of many important functions and services in the future, such as autonomous collision avoidance systems; robotic surgery; autonomous systems for search and rescue, firefighting, and exploration; automated traffic control; zero-net energy buildings; assistive technologies; and ubiquitous healthcare monitoring and delivery. The task force is directed to submit a report to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Science and Technology of the House of Representatives within one year.

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⁷³ The term “cyber-physical systems” refers to the tight conjoining of and coordination between computational and physical resources.