

March 3, 2010

The Honorable John Holdren  
Co-Chair, President's Council of  
Advisors on Science and Technology  
Director, Office of Science and  
Technology Policy  
White House  
1600 Pennsylvania Avenue, NW  
Washington, DC 20500

The Honorable Eric Lander  
Co-Chair, President's Council of  
Advisors on Science and Technology  
President and Director,  
Broad Institute  
7 Cambridge Center  
Cambridge, MA 02142

The Honorable Harold Varmus  
Co-Chair, President's Council of Advisors on Science and Technology  
President, Memorial Sloan-Kettering Cancer Center  
1275 York Avenue  
New York, NY 10065

Dear Drs. Holdren, Lander, and Varmus:

The Science, Technology, Engineering, and Mathematics (STEM) Education Coalition is pleased to provide comment to the President's Council of Advisors on Science and Technology (PCAST) as you move forward with a report on a wide range of policies related to STEM education.

As our country deals with the current economic downturn and prepares for a robust recovery, it is absolutely essential that we pay close attention to the role STEM education plays in ensuring the competitiveness of our workforce. To bolster our nation's STEM education system, we must employ a robust range of policies, solutions, and partnerships.

The STEM Education Coalition has actively promoted positive STEM education reform before Congress and the Executive Branch, and we have been engaged in many of the major legislative debates of the last several years, including the *Higher Education Opportunity Act*, the *America COMPETES Act*, efforts to reauthorize the *Elementary and Secondary Education Act*, and the annual appropriations process.

**As you proceed with your work, we respectfully request the following key principles be given strong consideration in your report to President Obama.**

**1. The Federal Government Must Provide Strong and Sustained Support for Key STEM Education Priorities**

*We strongly urge that PCAST recommends increased funding for NSF's EHR Directorate and the Math and Science Partnership Program at the U.S. Department of Education.*

*We urge the PCAST to carefully review STEM-focused education initiatives authorized in the Higher Education Act and America Competes Act as a part of your study of potential federal STEM education initiatives.*

*The PCAST report should include strong language that clarifies the roles and responsibilities of federal R&D mission agencies in STEM Education and calls for the coordination of STEM education programs across the federal agencies.*

*The PCAST report should also address the portion of the federal STEM portfolio dedicated to K-12 programs*

## **2. Science, Technology, Engineering, and Mathematics Education Must Be Clearly Defined**

*PCAST should include a clear definition of STEM education and define what STEM education means in the context of preparing the next generation to be career or college ready. Federal STEM education initiatives must include technology and engineering educators and programs. Computer science education should also be a major component within the STEM conversation.*

## **3. Stakeholders Must Work Toward the Alignment of STEM Education**

*To ensure that all students have an opportunity to learn 21st-century skills, we encourage PCAST to support the development and implementation of policies that will encourage a vertical alignment of P–20 STEM education that includes these stakeholders: Higher Education/Undergraduate, Community Colleges/CTE, After-School Programs, and Informal Education.*

## **4. STEM Teaching and Learning Must Be Improved**

*A systemic approach to improving teaching and learning in the STEM fields must focus on Standards, Assessments, and Accountability; Teacher Preparation and Professional Development; Increasing Diversity in the STEM Pipeline; Linking Research to Classroom Practice; Increasing Classroom Resources; and Recognizing the Importance of Informal Learning.*

More information on these key principles can be found in the white paper below. We appreciate the strong commitment of the Administration to addressing the challenges facing STEM education and our nation's competitiveness in the global economy and hope that the recommendations offered here will help inform your deliberations on this vitally important subject.

For any additional information on STEM education please do not hesitate to contact Coalition Co Chairs, James Brown (American Chemical Society) at 202-872-6229 or Jodi Peterson (National Science Teachers Association) at 703-312-9214.

Sincerely,

*Action Works*

*Aerospace Industries Association*

*Alabama Mathematics, Science, and Technology Education Coalition (AMSTEC)*

*Altshuller Institute for TRIZ Studies*

*American Association of Colleges for Teacher Education*

*American Association of Physicists in Medicine*

*American Association of Physics Teachers*

*American Association of University Women (AAUW)*

*American Astronomical Society*

*American Chemical Society*

*American Helicopter Museum & Education Center*

*American Institute of Aeronautics and Astronautics*

*American Institute of Biological Sciences*

*American Museum of Natural History*

*American Society for Engineering Education*

*American Society for Microbiology*

*American Society of Agronomy*

*American Society of Civil Engineers*

*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.*

*American Statistical Association*

*ASME Center for Public Awareness*

*Association for Computing Machinery*

*Association of Public and Land-grant Universities – APLU*

*Association of Science-Technology Centers*

*ASTRA*

*Baltimore Washington Corridor Chamber*

*Battelle*

*Biophysical Society*

*BSCS (Biological Sciences Curriculum Study)*

*Carnegie Corporation of New York*

*Center for Excellence in Education (CEE)*

*Center for Minority Achievement in Science and Technology (CMAST)*

*Computer Science Teachers Association*

*Computing Research Association*

*Council on Undergraduate Research*

*Crop Science Society of America*

*DEPCO, LLC*

*Destination ImagiNation, Inc.*

*EAST Initiative*

*Education Development Center, Inc.*

*Engineers Without Borders-USA*

*Entertainment Industries Council, Inc.*

*Exploratorium*

*Falcon School District 49 PreK-12 STEM Educational Initiative, Colorado Springs, CO*  
*Funutation Tekademy LLC*  
*Hands On Science Partnership*  
*Illinois Mathematics and Science Academy*  
*Institute for Advanced Study*  
*International Technology and Engineering Education Association (ITEEA)*  
*Knowles Science Teaching Foundation*  
*LearnOnLine, Inc*  
*Museum of Science and Industry, Chicago*  
*Museum of Science, Boston*  
*NASA STEM School Administrators Association*  
*National Alliance for Partnerships in Equity*  
*National Alliance for Partnerships in Equity Education Foundation*  
*National Center for Science Education*  
*National Center for Technological Literacy*  
*National Council for Advanced Manufacturing*  
*National Council of Teachers of Mathematics*  
*National Girls Collaborative Project*  
*National Science Teachers Association*  
*National Society of Professional Engineers*  
*National Youth Science Foundation*  
*NDIA*  
*Ohio Mathematics and Science Coalition*  
*Pathways into Science*  
*PBS*  
*Project Exploration*  
*Project Lead The Way*  
*PTC*  
*PTC-MIT Consortium*  
*Real World Design Challenge*  
*REVOLUTIONARY DESIGNS*  
*SAE International*  
*Science Teachers Association of New York State*  
*Society for the Advancement of Chicanos/Hispanics and Native Americans in Science*  
*(SACNAS)*  
*Society of Women Engineers (SWE)*  
*Soil Science Society of America*  
*South Carolina's Coalition for Mathematics and Science*  
*SPIE, the International Society for Optics and Photonics*  
*STEMES*  
*Technology Student Association*  
*The Society of Naval Architects and Marine Engineers*  
*Triangle Coalition*  
*Vernier Software & Technology*  
*Water Environment Federation*

Science Technology, Engineering and Mathematics (STEM) Education Coalition  
Key Recommendations to President's Council of Advisors on Science and Technology  
March 3, 2010

## **The Federal Government Must Provide Strong and Sustained Support for Key STEM Education Priorities**

For many educators in the field the federal government provides a vital source of support for STEM education programs. To promote meaningful education reform, the federal government must provide strong and sustained resources for STEM-focused education programs that provide direct assistance to educators and educational institutions.

We must increase the resource commitment to the National Science Foundation Education and Human Resources (EHR) Directorate. NSF education programs are designed to support and improve U.S. STEM education at all levels and in all settings—both formal and informal—and are unique in their capacity to move promising ideas from research to practice, to develop new and improved materials and assessments, to explore new uses of technology to enhance K–12 instruction, and to create better teacher training techniques. *We strongly urge that PCAST recommends increased funding for NSF's EHR Directorate going forward.*

We also strongly support the Mathematics and Science Partnership (MSP) program at the Department of Education, authorized via Title II, Part B of the No Child Left Behind Act. This program is the only dedicated source of funding for STEM education at the Department of Education and should be fully funded in future Administration budgets.

Beyond these two key federal STEM education funding sources, our Coalition has also supported a range of new STEM-focused education initiatives as authorized by the *Higher Education Act* and the *America COMPETES Act*, including the Math Now program, the Laboratory Science Pilot program, and integrated teacher education programs based upon the U-TEACH, Cal-TEACH and PhysTEC models. *We urge the PCAST to carefully review these two pieces of bipartisan and broadly supported legislation as a part of your study of potential federal STEM education initiatives.*

Finally, to ensure that federal STEM education programs are an efficient use of federal funds, the *PCAST report should include strong language that clarifies the roles and responsibilities of federal R&D mission agencies in STEM Education and calls for the coordination of STEM education programs across the federal agencies.*

Federal R&D mission agencies, particularly those with federal research facilities, have a unique role to play in STEM Education. They can provide students and educators with hands-on research and experimental learning opportunities with world-class scientists. It is critical that all federal agencies with STEM initiatives work together to ensure that the best practices to improve student learning are shared and widely replicated and their programs are properly implemented and evaluated.

*The PCAST report should also address the portion of the federal STEM portfolio dedicated to K-12 programs. As reported at the October meeting, the Federal agencies reported that a very small portion of their STEM funds actually went to K-12 programs.*

### **Science, Technology, Engineering, and Mathematics Education Must Be Clearly Defined**

*PCAST should include a clear definition of STEM education and define what STEM education means in the context of preparing the next generation to be career or college ready.*

Federal STEM education initiatives must include technology and engineering educators and programs. The term *engineering and technology education* means a curriculum and instruction that (a) uses technology as a way of teaching innovation using an engineering design process and context; (b) develops an understanding of technology through design skills and the use of materials, tools, processes, and resources; and (c) through the application of engineering and design principles and concepts, develops proficiency in abstract ideas and in problem-solving techniques.

Studies have shown that technology and engineering programs often provide the bridge between math and science and the much needed relevance to learning that will encourage students to pursue not only studies in the STEM fields but also STEM careers. The creative and problem-solving skills that are used in technology and engineering settings are critical to the development of the 21st-century workforce.

*Computer science education should also be a major component within the STEM conversation. Computing drives innovation, economic growth, and societal change. There is a tremendous need to expose students to computer science, yet there are numerous challenges, particularly in K–12 education. PCAST can take the lead in defining the need for an educational system that values computer science as a discipline.*

### **Stakeholders Must Work Toward the Alignment of STEM Education**

In the October 30, 2007, National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System, the National Science Board (NSB) points out: “*The nation faces two central challenges to constructing a strong coordinated STEM education system: Ensuring coherence in STEM learning and ensuring an adequate supply of well prepared and highly effective STEM teachers.*”

The NSB recommends that we must promote vertical alignment of STEM education across the grade levels by:

- Improving the linkages between high school and higher education and the workforce

- Creating or strengthening STEM education focused P–16 or P–20 councils in each state
- Encouraging alignment of STEM content throughout the P–12 education system

*To ensure that all students have an opportunity to learn 21st-century skills, we encourage PCAST to support the development and implementation of policies that will encourage a vertical alignment of P–20 STEM education that includes these stakeholders: Higher Education/Undergraduate, Community Colleges/CTE, After-School Programs, and Informal Education.*

### **STEM Teaching and Learning Must Be Improved**

A systemic approach to improving teaching and learning in the STEM fields must focus on Standards, Assessments, and Accountability; Teacher Preparation and Professional Development; Increasing Diversity in the STEM Pipeline; Linking Research to Classroom Practice; Increasing Classroom Resources; and Recognizing the Importance of Informal Learning.

#### ***Standards, Assessments, and Accountability***

The 2009 Carnegie Corporation of New York-Institute for Advanced Study report “The Opportunity Equation, Transforming Mathematics and Science Education for Citizenship and the Global Economy” calls on the nation to “Establish common standards that are fewer, clearer, and higher and that stimulate and guide instructional improvement and galvanize the nation to pursue meaningful math and science learning for all Americans.” *PCAST should support the efforts to develop common core standards in mathematics and science that are more focused, aligned, and coordinated with assessments and teacher professional development.*

#### ***Teacher Preparation and Professional Development***

*Government Accounting Office report GAO-06-114, Federal STEM Education Programs* notes “University officials frequently cited teacher quality as a key factor that affected domestic students’ interest in and decisions about pursuing STEM degrees and occupations . . . Researchers also noted that poor teaching at the university level was the most common complaint among students who left as well as those who remained in STEM fields. Students reported faculty do not like to teach, do not value teaching as a professional activity, and therefore lack any incentive to learn to teach effectively.”

*PCAST must address teacher preparation in the STEM fields. We must change university culture in fundamental ways to bridge the cultural divide between the schools of arts and science and schools of education and their efforts to encourage and retain more students in STEM fields. More collaboration between these communities would lead to stronger teacher preparation programs in science, mathematics, and technology and would vastly improve the “system” of education. Experiential, hands-on learning must also be extended to higher education undergraduate programs, including programs at community colleges.*

Long-term, coherent, reform-based professional development for STEM teachers is also essential. Ongoing quality professional development must increase and deepen content knowledge, promote a variety of pedagogical approaches, and develop questioning strategies, which will advance higher-order thinking of students. While it is commonplace for most businesses to invest funding in staff training, very few district dollars are budgeted for teacher professional development.

Increased federal funding for professional development will help state and local school districts provide STEM-specific professional development to both preservice and inservice teachers. Informal learning institutions can play a key role in both teacher professional development and preparation.

### ***Increasing Diversity in the STEM Pipeline***

According to The American Council on Education report “Increasing the Success of Minority Students in Science and Technology” “The nation's changing demographics and continued need to remain globally competitive make it clear that colleges and universities must increase the number of Hispanics and African Americans earning degrees in science, technology, engineering, and math (the STEM fields). Thirty-nine percent of people under age 18 in the United States are persons of color and this percentage will continue to increase placing young people of color at the vanguard of the next generation. It is upon this generation that the nation places its hopes for continued economic competitiveness in the Information Age.”

Similarly, women are also underrepresented in the STEM workforce. The Commission on Professionals in Science and Technology's 2007 report, "Professional Women and Minorities," noted that women make up 25% of the labor force in the STEM fields. However, that proportion varies widely, with fewer women in occupations that require a high level of skill in math, such as engineering. Women comprise no more than 15% of any engineering subdiscipline (i.e., mechanical, electrical, civil, industrial, etc.) and only 9.5% of engineering managers.

NAEP scores for grade four and eight math and science students tell us that many of these challenges to increase diversity in the STEM pipeline begin at the K–12 level. The average NAEP scores for students in urban areas are lower than the national average in both mathematics and science. We simply must find effective ways to reach these young people to ensure a high-quality STEM workforce in future years.

### ***Linking Research to Classroom Practice***

Critical research in STEM education must be implemented in our classrooms nationwide and used in a manner leading to increased student achievement in the STEM areas. Programs like the National Science Digital Library (NSDL) provide an outstanding resource and archive of peer-reviewed and edited on-line science education resources for K-20. Yet linking research to everyday classroom practice is a challenge for far too many districts. The problem is twofold. First, we simply must find better ways to link the community of STEM education researchers, including those in the federal agencies, with one another and with schools. Second, we must effectively disseminate and actively implement the

vast research findings that can and will have an impact on our schools and classroom teachers. *PCAST can recommend continued investments in research on teaching and learning that will better inform development of science, mathematics and engineering curricula and pedagogical approaches and suggest methods to better link this research to classroom practice.*

### ***Increasing Classroom Resources***

Teachers and schools must have requisite materials and equipment to properly teach the STEM subjects. Although no specific research is available on STEM educators specifically, according to the QED “2006–2007 Teacher Buying Behavior Report,” on average teachers report spending a total of \$475 of their own money on classroom materials and supplies. Forty-four percent of respondents spend over \$500 on their classrooms, with 20% spending over \$1,000, and 38% of teachers report needing materials that support differentiated instruction. *PCAST can encourage comprehensive federal policy that will ensure that STEM classrooms are adequately supported.*

### ***Recognizing the Importance of Informal Education***

According to the National Research Council report “Learning Science in Informal Environments: People, Places, and Pursuits,” people do, in fact, learn science in a variety of nonschool settings. Among those are “designed spaces” like museums, science centers, zoos, aquariums, and environmental centers, which as the NRC states are “rich with real-world phenomena, these are places where people can pursue and develop science interests, engage in science inquiry, and reflect on their experiences through sense-making conversations.” *PCAST should support a strong federal investment in informal STEM learning for Americans of all ages and backgrounds.*