October 23, 2009

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

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:

On behalf of the National Science Teachers Association, the largest organization in the world promoting excellence and innovation in science teaching and learning for all, thank you for your commitment to STEM education. As the leader in science education, NSTA reaches over 300,000 teachers every week, and we work to engage teachers of science nationwide and improve student learning by providing a vast array of products, services, and programs. Our current membership includes science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in science education.

NSTA enthusiastically embraces the concept of STEM education, and we value the importance of engineering and technology in the K-12 curriculum. We welcome this opportunity to provide input to PCAST. We will be limiting our recommendations primarily to science education.

As you know, there have been some promising indicators for science and math education in the United States recently:

- ✓ In 2006, slightly more than half the states required 3 or more years of both mathematics and science courses for high school graduation. (*Science and Engineering Indicators 2008*)

- ✓ More students are taking advanced science classes; student course completion rates have increased since 1990 in advanced biology, chemistry, and physics, although they

leveled off between 2000 and 2005. (*Science and Engineering Indicators 2008*) Growth was especially strong in mathematics. The Class of 2005 graduates completed mathematics courses at far higher rates than their 1990 counterparts in all categories except trigonometry/algebra III. The proportion of students completing courses in precalculus/analysis, calculus, and Advanced Placement/International Baccalaureate (AP/IB) calculus at least doubled since 1990. (*Science and Engineering Indicators 2008*)

- ✓ The National Math and Science Initiative posted a 71.5 percent increase in AP exams passed in math and science by African American students as compared to 13 percent nationally.

- ✓ More teachers are teaching "in-field." Nationally, 61 percent of secondary mathematics teachers in U.S. public schools majored in their field, and 77 percent of science teachers majored in their field (CCSSO *State Science and Mathematics Education Indicators 2007*)

Unfortunately while many of these indicators are encouraging signs, we still have a long way to go. Overall student achievement in science is sadly lacking. In 2005 only 29 percent of fourth grade students, 29 percent of eighth grade students, and only 18 percent of 12th grade students scored proficient on the NAEP science exam. These scores have been virtually unchanged since 1996.

Years of research from the 2007 *Trends in International Mathematics and Science Study* (TIMSS) tell us that U.S. students do not perform well in mathematics and science as compared to students in many economically developed countries. Science scores for both fourth and eighth grade students have remained flat since 1995 and scores for minority students are dismal.

It is our belief that building the human capacity to educate students to be internationally competitive will require the nation to first address four major challenges to improve science education. Many of these recommendations are not new and have been presented in various reports over the past few years.

Challenge Number One: Lack of Coordination between K-12, Higher Education (Including Community Colleges) and Career and Technical Education (CTE)

Currently students do know what is expected of them as they move from middle school to high school, and then from high school on to post secondary education. There are internal barriers at these major transition points for students, such as weak career counseling and job awareness connected to course and performance expectations, low course expectations for students, poor articulation across grade transition points (e.g. grade 8 to 9, grade 12 to 13) and institutional barriers such as courses for some students and not others, preventing those students from advancing to the courses they need.

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 National Science Teachers Association agrees with the NSB recommendation that we must promote vertical alignment of STEM education across the grade levels from PreK through the first years of higher education 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

Recommendation: PCAST should support the development and implementation of policies that will encourage a vertical alignment of STEM education.

Challenge Number Two: Disconnected Infrastructure in Science Education (Standards and Assessments and Professional Development) Resulting in Uneven Delivery of Science

Standards and Assessments: The policies and instruments that are used for determining students' performance and success in science are irregular and uneven within states and across this country. A coherent science education system can provide all students with the knowledge and skills necessary for life in the 21st century. The recent Wallace Foundation report (2009) titled *Research Findings to Support Effective Educational Policymaking* states: "*Close collaboration between states and districts has not been the historic norm. It is complex, time consuming and challenging to maintain. And it takes the sustained backing of top government and education leaders with the authority to make changes happen.*"

The National Science Teachers Association agrees with the 2009 Carnegie Corporation report titled *The Opportunity Equation, Transforming Mathematics and Science Education for Citizenship and the Global Economy* and calls on the nation to **"***Establish common science 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.*"

These common national K–12 science education standards should be drawn from current national standards documents, and be more streamlined and focused, and organized around a small number of big ideas rooted in the major fields of science that develop over the K–12 span and include crosscutting concepts and skills that would unite the disciplines in a deep, meaningful way.

National assessments and accountability mechanisms should be developed aligned to common science standards. This will enable schools to better guide instructional improvement and

innovation in science. Students can move from school to school, and state to state and find similar expectations and accountability measures.

Teacher Professional Development: Long term, coherent, reform-based professional development is essential for all teachers of science. Research shows after 80 to 100 hours of professional development, teachers reported more inquiry based practices. Professional development should focus on content knowledge, active learning, and be coherent with other activities. Significant in improving these are collaborative learning opportunities, groups of teachers from the same school, and the duration of the professional development program.

The NSTA strongly agrees with the National Research Council 2006 report *Taking Science to School: Learning and Teaching Science in Grades K-8* that "*state and local school systems should ensure that all K-8 teachers experience sustained science-specific professional development in preparation and while in service. Professional development should be rooted in the science that teachers teach and should include opportunities to learn about science, about current research on how children learn science, and about how to teach science*."

Recommendation: PCAST can assist the science and education communities efforts to develop common standards that are more focused, aligned, and coordinated with assessments and advocate for quality, evidence based teacher professional development experiences.

Challenge Number Three: Lack of Funding For Equipment and Supplies

It is unfair to have high expectations for students if teachers and schools do not have the requisite materials and equipment to properly teach science. A 1995 U.S General Accounting Office (GAO) report found that 42 percent of schools surveyed reported they were not well equipped in the area of laboratory science. A second 2000 GAO report found that approximately 40 percent of college students who left the sciences reported problems related to high school science preparation. This under preparation was linked to problems such as a poor preparation in math and lack of laboratory experiences or exposure to computers.

Abstract learning does not provide students with the understanding of science needed for problem solving and innovative thinking, but rather memorization of information. Developmentally appropriate laboratory experiences are essential for both middle level and high school aged students, yet these experiences for a large number of students are abysmal. Far too many schools have undertrained or inadequately supported teachers, outdated lab equipment and insufficient materials-or in many cases no labs at all.

Although no specific research is available on science 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. 44% 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.

Recommendation: PCAST can encourage comprehensive federal policy that will ensure that STEM classrooms are adequately supported.

Challenge Number Four: Equity Issues in Science Education

Underrepresented minorities represent 34% of those aged 18-24 in the United States. We will need to find effective ways to reach these young people if we want a high quality STEM workforce in future years. While we all recognize this issue and it has been widely documented, only a few targeted yet disconnected programs are having success so the problem of disaffected minority students persists.

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 (U.S. Census Bureau, 2000), 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*."

In 2000–01, only about 13 percent of bachelor degrees awarded to African Americans and Hispanics were in the STEM fields, compared with 31 percent for Asian Americans and 16 percent for whites. These figures have changed little over the past decade. (American Council on Education *Increasing the Success of Minority Students in Science and Technology)*

A closer look at the data reveals that African Americans and Hispanics enter higher education with the same level of interest in the STEM fields as their peers, but that they fail to persist in these majors at the same rate as their white and Asian-American classmates. (American Council on Education *Increasing the Success of Minority Students in Science and Technology)*

.
The NAEP Science 2005 Trial Urban District Assessment (TUDA) tells us that many of these challenges begin at the K-12 level:

- The 4th Grade Average NAEP Science Scores for the nation are 149. In the NAEP TUDA study of ten urban areas (Austin, Charlotte, Houston, San Diego, New York City, Atlanta, Boston, Cleveland, Chicago and Los Angeles), only one city (Austin) scored 147; the other nine urban city scores are significantly below the national average

- There is a wide disparity between the national percentile ranking of white students and black and Hispanic students in the same urban area. For example, Atlanta white students ranked at the 86th percentile, while Atlanta black students ranked at the 22 percentile.

- The 8th Grade average NAEP science score for the nation is 147. The 8th graders scores in each urban area assessed were significantly below the national average.

- In nine out of ten urban areas, more than half of the students scored at the below basic level in science.

Recommendation: PCAST should recommend the development of policies that would focus on underserved populations and ensure resources are targeted as needed.

To summarize we believe there are four key challenges and opportunities in science education:

1. Lack of coordination in grades pK-16 curriculum and instruction, which results in many unqualified students going on to higher levels of learning;

2 Disconnected Infrastructure in science education (standards, assessments and professional development);

3. Lack of funding for equipment and supplies, causing students to be disadvantaged in their learning;

4. Equity of opportunity to learn science.

Together these challenges contribute to a system of science education that precludes students from future success in STEM fields and poses a serious threat to our nation's competitiveness. Targeting the first two can contribute greatly to the overall systematic improvements that are required. These challenges can be addressed with a thoughtful approach from policymakers that include key leverage points for improving the science educational system.

Thank you for your support of science education. If you have any additional questions please contact me at feberle@nsta.org or at 703-312-9255.

Sincerely,

Francis Eberle
Executive Director
National Science Teachers Association