U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

HEARING CHARTER

What Makes for Successful K-12 STEM Education: A Closer Look at Effective STEM Education Approaches

October 12, 2011, 10:00 a.m.
2318 Rayburn House Office Building

1. Purpose

On Wednesday, October 12, 2011, at 10:00 a.m., the Subcommittee on Research and Science Education will hold a hearing to review and examine the findings of the National Research Council Report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, as requested by Congress in 2009 to identify highly successful K-12 schools and programs in STEM.

2. Witnesses

Dr. Adam Gamoran, Director, Wisconsin Center for Education Research, University of Wisconsin

Mr. Mark Heffron, Director, Denver School for Science and Technology: Stapleton High School

Dr. Suzanne Wilson, Chair, Department of Teacher Education, Division of Science and Math, Education, Michigan State University

Dr. Elaine Allensworth, Senior Director and Chief Research Officer, Consortium on Chicago School Research, University of Chicago

Dr. Barbara Means, Director, Center for Technology in Learning, SRI International

3. Overview

- In the U.S, student mastery of STEM subjects is essential to thrive in the 21st century economy. As other nations continue to gain ground in preparing their students in these critical fields, the U.S. must continue to explore a variety of ways to inspire future generations.

- The 2007 *Rising Above the Gathering Storm* report called for an increased emphasis on recruiting, educating, training, and increasing the skills of K-12 STEM education teachers and increasing the pipeline of American students who are prepared to enter college and graduate with a degree in STEM.

- In 2009, Congress directed the National Science Foundation (NSF) to survey highly successful K-12 STEM schools and "report recommendations on how their STEM practices might be more broadly replicated in the U.S. public school system."[1]

- In June 2011, the National Research Council released the NSF-sponsored report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*.

4. Background

STEM Education and the Federal Government

A consensus exists that improving STEM education throughout the Nation is a necessary condition for preserving our capacity for innovation and discovery and for ensuring U.S. economic strength and competitiveness in the international marketplace of the 21st century. The National Academies *Rising Above the Gathering Storm* report placed major emphasis on the need to improve STEM education and made its top priority increasing the number of highly qualified STEM teachers. This recommendation was embraced by the House Science, Space, and Technology Committee following the issuance of the report and was included in the 2007 *America COMPETES Act*. The 2010 *America COMPETES Reauthorization Act* continues this priority.

Beyond activities authorized in *America COMPETES*, President Obama has called for a new effort to prepare 100,000 science, technology, engineering, and math (STEM) teachers with strong teaching skills and deep content knowledge over the next decade. As a component of achieving this goal, the FY12 Budget Request proposes an investment of $100 million through the Department of Education and the National Science Foundation (NSF) to prepare effective STEM teachers for classrooms across America. This proposal also responds to a recommendation by the President's Council of Advisors on Science and Technology (PCAST) to prepare and inspire America's students in science, technology, engineering, and mathematics.[2]

In addition, the FY12 Budget Request proposes $90 million for the creation of an Advanced Research Projects Agency – Education (ARPA-ED) with the mission of driving transformational improvements in education technology.[3]

The President's new "Educate to Innovate" campaign leverages federal resources with over $700 million in private-sector resources. The goals of the program are to increase STEM literacy so that all students can learn deeply and think critically in science, math, engineering, and technology; move American students from the middle of the pack to top in the next decade; and expand STEM education and career opportunities for underrepresented groups, including women and girls.

With specific regard to K-12 STEM education funding beyond what has already been identified, the FY12

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[1] Report to Accompany the Commerce, Justice, Science and Related Agencies Appropriations Act for FY2010 (House Report 111-149).

[2] White House Office of Science and Technology Policy, *Winning the Race to Educate Our Children,* STEM Education in the 2012 Budget, p.1

[3] White House Office of Science and Technology Policy, *Winning the Race to Educate Our Children,* STEM Education in the 2012 Budget, p.1

Budget Request calls for $206 million for the Department of Education's proposed Effective Teaching and Learning in STEM program; a $60 million (28 percent) increase for NASA's K-12 education programs; $300 million for an "Investing in Innovation" program (expansion of a Department of Education American Reinvestment and Recovery Act program); and $185 million for a new Presidential Teaching Fellowship program.

In total, the FY12 Budget Request devotes $3.4 billion to STEM education programs across the Federal government.[4] The 2010 *America COMPETES Reauthorization Act* called for the creation of a National Science Technology Council (NSTC) Committee on STEM Education to coordinate federal STEM investments. The first-year tasks of the Committee are to create an inventory of federal STEM education activities and develop a 5-year strategic Federal STEM education plan. The inventory, as well as a similar Government Accountability Office (GAO) survey requested by the Committee on Education and Workforce, is currently underway and results are expected in early 2012.

In the 112th Congress, the Science, Space, and Technology Committee will continue to hold oversight hearings and briefings on STEM education activities across the federal government and will closely monitor the scope and findings of both the NSTC and the GAO federal STEM education inventories.

The "Successful K-12 STEM Education" Report

In 2009, Congress directed the National Science Foundation (NSF) to survey highly successful K-12 STEM schools and "report recommendations on how their STEM practices might be more broadly replicated in the U.S. public school system."[5]

In October 2010, the National Research Council brought together a group of experts to explore the issue. This Committee of experts was charged with "outlining criteria for identifying effective STEM schools and programs and identifying which of those criteria could be addressed with available data and research, and those where further work is needed to develop appropriate data sources."[6] In addition, a public workshop was held in May 2011 to "refine criteria for success, explore models of 'best practice,' and analyze factors that evidence indicates lead to success" in highly successful K-12 schools. In late June 2011, they released the NSF-sponsored report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*.

The report identifies three goals for successful STEM education in the United States[7]:

1. **Expand the number of students who ultimately pursue advanced degrees and careers in STEM fields and broaden the participation of women and minorities in those fields**. A number of reports directly link the Nation's economic competitiveness to the ability of K-12 STEM education to produce the next generation of scientists, engineers, and innovators. Given changing demographics in the U.S. and the need to produce more STEM-career prepared students, increasing the participation of underrepresented groups in the sciences is important.

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[4] White House Office of Science and Technology Policy, *Innovation, Education, and Infrastructure: Science, Technology, STEM Education, and 21st Century Infrastructure in the 2012 Budget*, p. 2.

[5] Report to Accompany the Commerce, Justice, Science and Related Agencies Appropriations Act for FY2010 (House Report 111-149).

[6] *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, National Research Council, 2011. (http://www.nap.edu/catalog.php?record_id=13158) p. 1.

[7] Ibid, p. 4.

2. **Expand the STEM-capable workforce and broaden the participation of women and minorities in that workforce**. In addition to preparing those students for advanced degrees, it is also necessary to prepare students for STEM-related careers, such as medical assistants and computer technicians. "Sixteen of the 20 occupations with the largest projected growth in the next decade are STEM related, but only 4 of them require an advanced degree."[8] Typically, these careers require vocational certification, an associate's degree, or a bachelor's degree.

3. **Increase STEM literacy for all students, including those who do not pursue STEM-related careers or additional study in the STEM disciplines**. The challenges of the science- and technology-driven 21st century increasingly dictates that everyone have knowledge and understanding of STEM concepts for personal decision making, participation in civic and cultural affairs, and economic productivity.

In order to identify what makes a successful school able to achieve one or all of the broad goals, the report establishes three criteria for success[9]:

1. **Student STEM Outcomes.** Since achievement test data are widely available and used for accountability purposes, they are most commonly used to gauge student and school success, but test scores do not always tell the whole story. It is difficult to measure interest, motivation, and creativity, all important for success in STEM. Likewise, utilizing STEM content knowledge is required in numerous settings other than tests, like navigating financial aid forms or working in teams, but currently these are not measures of success. The same can be said for participating in after school programs or internships, as they could indicate a student's engagement in a STEM activity, but they are not factored in as a measurement of success. Research gaps exist on student outcomes.

2. **STEM-Focused School Types.** The report acknowledges the difficulty in identifying schools and programs that are the most successful in STEM because "success is defined in many ways and can occur in many different types of schools and settings, with many different populations of students." [10] As such, three broad categories of STEM-focused schools are identified that have the potential to meet the overarching goals for U.S. STEM education: selective schools, inclusive schools, and schools with STEM-focused career and technical education (CTE).

   Selective STEM schools tend to be focused around one or more STEM disciplines and have selective admissions criteria with highly talented and motivated students, expert teachers, and advanced curricula. They can be state residential schools, stand-alone schools, schools-within-a-school or regional centers with half-day courses. Research gaps exist on the contributions of these schools over regular schools.

   Inclusive STEM schools are similar to selective STEM schools but have no selective admissions criteria, thereby serving a broader population. Many work under the auspices that "math and science competencies can be developed, and that students from traditionally underrepresented subpopulations need access to opportunities to develop these competencies to become full participants in areas of economic growth and prosperity."[11]

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[8] Ibid, p. 5.

[9] Ibid, p. 6.

[10] Ibid. p. 8.

[11] Ibid, p. 11.

Schools and programs with STEM-focused CTE allow students to explore STEM-related career options by learning practical applications of STEM subject areas and are intended "to prepare students for STEM-related careers, often with the broader goal of increasing engagement to prevent students from dropping out of school."[12] Many CTE programs and schools are highly regarded, but research gaps exist on their effectiveness.

The report recognizes the contribution of comprehensive schools in STEM education as well, as "much of the available research knowledge of effective practices comes from comprehensive schools, which educate the vast majority of the nation's students – including many talented and aspiring scientists mathematicians, and engineers who might not have access to selective or inclusive STEM-focused schools."[13] These schools are not focused specifically on STEM, but cover all disciplines. Advanced Placement (AP) and International Baccalaureate (IB) programs provide advanced STEM programs in these schools.

3. **STEM Instruction and School Practices.** Looking at outcomes and focusing on practices provide schools with guidance on improving STEM instruction. Two themes tend to be found in successful schools, "instruction that captures students' interest and involves them in STEM practices and school conditions that support effective STEM instruction."[14] Imperative to instruction are a coherent set of standards and curriculum, teachers with high capacity to teach in their discipline, a supportive system of assessment and accountability, adequate instruction time, and equal access to high-quality STEM learning opportunities.[15]

   At the same time, while teacher qualifications are important, school conditions and cultures that support learning are just as, if not more, important. Specifically, a successful school should have: 1) school leadership as the driver for change, a strategic, focused principal; 2) professional capacity, with quality professional development and an ability for faculty to work together; 3) active parent-community ties, to engage parents in supporting their children's success; 4) student-centered learning climate that is safe, welcoming, stimulating, and nurturing; and 5) instructional guidance when it comes to curriculum organization and instructional materials.

   A number of research gaps are identified throughout the report. Much research is underway, but not yet conclusive. Broadening research on measuring success beyond student test scores, graduation rates, and data on effective STEM practices could allow for a more comprehensive analysis of schools and K-12 STEM education.[16]

The report concludes with recommendations for what schools and districts and state and national policy makers can do to support effective K-12 education[17]:

Schools and Districts

- Consider all three models of STEM-focused schools if seeking to improve STEM outcomes beyond comprehensive schools;

[12] Ibid, p. 13.

[13] Ibid, p. 15.

[14] Ibid. p. 18.

[15] Ibid. p. 19-22.

[16] Ibid, p. 26.

[17] Ibid, p. 27.

- Devote adequate instructional time and resources to science in grades K-5;
- Ensure STEM curricula are focused on the most important topics in each discipline, are rigorous, and are articulated as a sequence of topics and performances;
- Enhance the capacity of K-12 teachers; and
- Provide instructional leaders with professional development that helps to create the school conditions that appear to support student achievement.

State and Local Policy Makers

- Elevate science to the same level of importance as reading and mathematics and develop effective systems of assessment;
- Invest in a coherent, focused, and sustained set of support for STEM teachers; and
- Support key areas for future research.