

**ASSESSMENT OF THE NATIONAL
SCIENCE BOARD'S ACTION PLAN
FOR STEM EDUCATION**

HEARING
BEFORE THE
SUBCOMMITTEE ON RESEARCH AND
SCIENCE EDUCATION
COMMITTEE ON SCIENCE AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

OCTOBER 10, 2007

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**ASSESSMENT OF THE NATIONAL SCIENCE
BOARD'S ACTION PLAN FOR STEM EDU-
CATION**

WEDNESDAY, OCTOBER 10, 2007

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:08 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

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Subcommittee on Research and Science Education

Hearing on:

***Assessment of the National Science Board's Action Plan for STEM
Education***

October 10, 2007
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building
Washington, DC

WITNESS LIST

Dr. Steven Beering
Chairman
National Science Board

Ms. Judy A. Jeffrey
Director
Iowa Department of Education
Representing the Council of Chief State School Officers

Dr. Francis "Skip" Fennell
President
National Council of Teachers of Mathematics

Ms. Chrisanne Gayl
Director of Federal Programs
National School Boards Association

Dr. Robert Semper
Executive Associate Director
The Exploratorium
Representing the Association of Science-Technology Centers

Ms. Susan L. Traiman
Director
Education and Workforce Policy
Business Roundtable

HEARING CHARTER

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

**Assessment of the National
Science Board's Action Plan
for STEM Education**

WEDNESDAY, OCTOBER 10, 2007
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Wednesday, October 10, 2007, the Research and Science Education Subcommittee will hold a hearing to receive testimony related to a proposal from the National Science Board (NSB): “A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System.” This plan, which was released by the NSB on October 3, proposes a series of steps that the Board believes will bring greater coherence to the Nation’s science, technology, engineering and mathematics (STEM) education system and ensure that students are taught by highly effective STEM teachers.

2. Witnesses

Dr. Steven Beering, Chairman, National Science Board.

Ms. Judy A. Jeffrey, Director, Iowa Department of Education and Representing the Council of Chief State School Officers.

Dr. Francis (Skip) Fennell, President, National Council of Teachers of Mathematics and Professor of Education at McDaniel College.

Ms. Chrisanne Gayl, Director of Federal Programs, National School Boards Association.

Dr. Robert Semper, Executive Associate Director, The Exploratorium and Representing the Association of Science-Technology Centers.

Ms. Susan L. Traiman, Director, Education and Workforce Policy Business Roundtable.

3. Overarching Questions

- Does the NSB Action Plan address the key issues for improving STEM education: effective coordination of STEM education reform activities, nationally applied STEM content guidelines, horizontal and vertical alignment and coherence of STEM education, and populating classrooms with well qualified and highly effective STEM teachers? What are the principal barriers to achieving the recommended changes to the STEM education system?
- Is the proposed National STEM Education Council needed in order to implement the NSB’s recommendations; can it be made to work as envisioned; will the principal stakeholders, who must be engaged in order for it to function, embrace the concept; and can it become self-sustaining?
- What are the key issues in attracting STEM majors to teaching careers; educating them to be effective teachers; and retaining them in these careers?
- What is the federal role in carrying out the recommendations of the NSB Action Plan?

4. Brief Overview

- A consensus now exists that improving STEM education throughout the Nation is a necessary, if not sufficient, 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 a 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 COMPETES bill developed by the Committee, which was recently enacted.
- In the same period that the Gathering Storm report was being developed, the NSB initiated a process to explore how to improve STEM education throughout the Nation. As part of this effort, the Board established a STEM education commission to advise it on how to accomplish this goal. The Action Plan that is the subject of this hearing grew out of these activities.
- The NSB Action Plan focuses on coordinating what, when, and to whom STEM subjects are taught among states (horizontally) and across grade levels (vertically) and on ensuring students are taught by highly effective STEM teachers.
- At present, there are no consistent STEM content standards in use among the states and no consistency in the sequence in which STEM courses are taught. In a highly mobile society, this causes students who move from one state to another often to miss exposure to important concepts which they may not have a later opportunity to master. No formal mechanisms now exist to foster coordination regarding content and course sequence among states. Vertical integration of course sequence and content at different grade levels within states is beginning to be addressed through P-16 Councils that several states have initiated.
- A chronic shortage of highly qualified STEM teachers is a major impediment to improved student performance in STEM subjects. A high proportion of STEM teachers have neither an undergraduate major nor certificate to teach STEM subjects. There is a lack of uniformity and rigor in the requirements for certification of STEM teachers. Individuals with an interest and capability to pursue STEM degrees have many opportunities for careers in professions offering higher salaries and better working conditions.
- A central recommendation of the NSB report is to establish an independent, non-federal, congressionally chartered National Council for STEM Education. This Council, which would have representation from all the major public and private stakeholder groups, would coordinate and facilitate STEM education initiatives across the Nation. The NSB sees the Council as having an important role in facilitating a strategy to define voluntary STEM content guidelines, in developing consensus-based metrics for assessing student performance, in serving as a forum on best practices in STEM teaching and learning, in assisting the states in creating new and strengthening existing P-16 councils, in developing strategies to overcome barriers to increasing the compensation for STEM teachers, in coordinating and disseminating information on models to attract and support talented students in pursuing STEM teaching careers, and in fostering the development of national STEM teacher certification guidelines.

5. NSB Action Plan

Beginning in 2005 the NSB held a series of hearings in different regions of the U.S. to gather a range of views about how to improve STEM education. This led to the Board convening a national commission on STEM education to advise it on specific actions that could be taken to implement the many recommendations of previous reports, panels, task forces, and commissions that have called for major reforms of STEM education. The NSB commission presented their findings and recommendations to the Board in March 2007 (included as an appendix to the NSB Action Plan).

The NSB then prepared its STEM education Action Plan, released it for public comment in August, and then released the final version last week. The executive summary of the report, as released for public comment, is in the appendix to this memo, and the full report is available at http://www.nsf.gov/nsb/edu_com/draft_stem_report.pdf

6. Questions for the Witnesses

In the invitation letter for the hearing, Dr. Beerling was asked to provide an overview of the NSB's recommendations and the findings that led to these recommendations. He was also asked to describe the process used by the Board that led to the priorities reflected in the Action Plan, including the degree and nature of consultation with STEM education leaders throughout the Nation, and a description of the reaction the Board received to the recommendations of the Action Plan after it was released for public comment.

The other witnesses, who represent various stakeholder communities engaged in STEM education improvement, were asked to give their views on the NSB recommendations and to respond to the following questions:

- Does the NSB Action Plan address what you see as the key issues for improving STEM education? Are there specific actions or policies that you believe are important to improvement of STEM education that are not included? What are the principal barriers to achieving the recommended changes to the STEM education system?
- Is the proposed national STEM education council needed in order to implement the NSB's recommendations; can it be made to work as envisioned; and can it become self-sustaining? Do you support establishing this council? Do you have recommendations for changing the proposed structure or functions of the council? Furthermore, what role do you envision for the council in defining the recommended "national content guidelines"?
- What is the appropriate federal role in carrying out the recommendations of the NSB Action Plan?

APPENDIX

NSB-07-114
OCTOBER 1, 2007

A NATIONAL ACTION PLAN FOR ADDRESSING THE CRITICAL NEEDS OF THE U.S. SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS EDUCATION SYSTEM

EXECUTIVE SUMMARY

The United States possesses the most innovative, technologically capable economy in the world, and yet its science, technology, engineering, and mathematics (STEM) education system is failing to ensure that all American students receive the skills and knowledge required for success in the 21st century workforce. 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.

In order to direct attention to pressing issues and concerns in STEM education and to coordinate and enhance STEM education across local, State, and federal programs, the National Science Board (Board) recommends the following:

- The U.S. Congress should pass and the President should sign into law an act chartering a new, independent, non-federal *National Council for STEM Education* to coordinate and facilitate STEM programs and initiatives throughout the Nation, as well as to inform policy-makers and the public on the state of STEM education in the United States.
- The President's Office of Science and Technology Policy should create a standing Committee on STEM Education within the *National Science and Technology Council* with the responsibility to coordinate all federal STEM education programs.
- The *Department of Education* should create a new Assistant Secretary of Education position charged with coordinating the Department's efforts in STEM education and interacting with stakeholders outside the Department.
- The *National Science Foundation* should lead an effort to create a national roadmap to improve pre-kindergarten to college and beyond (P-16/P-20) STEM education, drawing on its national standing in the science and engineering communities and its expertise in science and engineering research and education.

In recognition of the lead role of local and State jurisdictions in the Nation's P-12 education system, the Board recommends that all stakeholders work together, using the National Council for STEM Education as the focal point, to provide *horizontal* coordination of STEM education among states by:

- Facilitating a strategy to define national STEM content guidelines that would outline the essential knowledge and skills needed at each grade level;
- Developing metrics to assess student performance that are aligned with national content guidelines;
- Ensuring that assessments under No Child Left Behind promote STEM learning; and
- Providing a forum to share and disseminate information on best practices in STEM teaching and learning.

The Board also recommends that all stakeholders promote *vertical* alignment of STEM education across grade levels—from pre-K through the first years of higher education by:

- Improving the linkage between high school and higher education and/or the workforce; and
- Creating or strengthening STEM education-focused P-16 or P-20 councils in each state; and
- Encouraging alignment of STEM education content throughout the P-12 education system.

Finally, the Board recommends actions that ensure students are taught by well-qualified and highly effective STEM teachers. These include strategies for increasing the numbers of such teachers and improving the quality of their preparation by:

- Developing strategies for compensating STEM teachers at market rates;
- Providing resources for the preparation of future STEM teachers;
- Increasing STEM teacher mobility between districts by creating national STEM teacher certification standards; and
- Preparing STEM teachers to teach STEM content effectively.

This Action Plan lays out a structure that will allow stakeholders from local, State, and Federal governments, as well as non-governmental STEM education stakeholder groups, to work together to coordinate and enhance the Nation's ability to produce a numerate and scientifically and technologically literate society and to increase and improve the current STEM education workforce. Strategies for producing the next generation of innovators are not explicitly addressed in this Action Plan and will require subsequent study. A coherent system of STEM education is essential to the Nation's economy and well-being.

Chairman BAIRD. I call to order this hearing to review the Action Plan for improving Science, Technology, Engineering, and Mathematics, or STEM education, that was recently released by the National Science Board. I welcome this opportunity to enter into a discussion with our panel of witnesses on the steps necessary to insure that American students receive the education in STEM fields that they will all need to live satisfying and productive lives in the increasingly technological society of the 21st century and that a subset of our students will need in preparation for becoming future scientists and engineers and, hopefully, teachers as well.

There is a convergence of views by Congress, the Administration, and business and industry that STEM education improvement is a key factor for ensuring the Nation's future well being and economic competitiveness. The *COMPETES Act*, which was signed into law this summer, includes many provisions aimed at addressing shortcomings in STEM education that were highlighted in the Congressionally-requested and widely acclaimed report from the National Academies, the so called "*Rising Above the Gathering Storm*" report.

The National Science Board has now come forward with a set of recommendations that are intended to make system-wide changes to improve STEM education throughout the Nation. The Board's recommendations fall into two principal areas: ensuring greater coherence in the Nation's STEM education system and ensuring that all students are taught by highly-qualified STEM teachers.

Educating more highly-qualified STEM teachers and enhancing the content knowledge and teaching skills of existing STEM teachers was the top recommendation of the "*Gathering Storm*" report. This recommendation was in turn the basis for the teacher education and professional development provision in the *COMPETES* legislation. The National Science Board now goes further by suggesting the need for policies to allow for increased teacher compensation and for development of more uniform teacher certification standards across the states.

In addition, the Board suggests specific actions that are needed to bring about greater coherence in the STEM education system, something Dr. Ehlers and I are particularly interested in. These recommendations include, for example, consistent content standards across states, uniform sequencing of courses from grade to grade across school systems and states, and improved linkage between the course content for different grade levels.

Today we will explore these proposals with representatives of various stakeholders involved in STEM education. This is appropriate because any changes to the STEM education system must involve active participation by many players. After all, there are 14,000 school districts in the United States, and any change to STEM education content and sequence, for example, would require developing and implementing a national strategy.

The Board makes a specific recommendation for implementing a national coordination process based on the creation of a Congressionally-chartered, independent council with a wide-ranging membership. I hope to hear from our witnesses their views on whether this is a necessary and workable mechanism.

Finally, I would like to thank the National Science Board for its strong reaffirmation in the report that STEM education is a core mission of the National Science Foundation. As the Board and this committee are well aware, STEM education has been a major component of NSF's activities since the agency's creation nearly 60 years ago, and the foundation has compiled a widely-acknowledged record of accomplishment over those years.

I strongly endorse the Board's direction to NSF to develop a roadmap for overall STEM education activities, including those funded through the science directorates. This is consistent with the requirement for a STEM Education plan in the recent NSF reauthorization legislation. The Committee will be watching with interest as this planning process unfolds.

I want to thank all our witnesses for their attendance this morning, and I look forward to our discussion.

I now recognize my friend, the Ranking Member of the Subcommittee, Dr. Vern Ehlers, for any opening remarks he may care to make.

[The prepared statement of Chairman Baird follows:]

PREPARED STATEMENT OF CHAIRMAN BRIAN BAIRD

I now call to order this hearing to review the Action Plan for improving science, technology, engineering, and mathematics—or STEM—education that was recently released by the National Science Board. I welcome this opportunity to enter into a discussion with our panel of witnesses on the steps that are necessary to ensure that American students receive the education in STEM fields that they will all need to live satisfying and productive lives in the increasingly technological society of the 21st century and that a subset of them will need in preparation for becoming future scientists and engineers.

There is a convergence of the views of Congress, the Administration, and business and industry that STEM education improvement is a key factor for ensuring the Nation's future well being and economic competitiveness. The *COMPETES Act* which was signed into law this summer includes many provisions aimed at addressing shortcomings in STEM education that were highlighted in the congressionally requested and widely acclaimed report from the National Academies, *Rising Above the Gathering Storm*.

The National Science Board has now come forward with a set of recommendations that are intended to make system-wide changes to improve STEM education throughout the Nation. The Board's recommendations fall into two principal areas: ensuring greater coherence in the Nation's STEM education system and ensuring that all students are taught by highly qualified STEM teachers.

Educating more highly qualified STEM teachers and enhancing the content knowledge and teaching skills of existing STEM teachers was the top recommendation of the *Gathering Storm* report. This recommendation was in turn the basis for the teacher education and professional development provisions in the *COMPETES* legislation. The National Science Board goes further by suggesting the need for policies to allow for increased teacher compensation and for development of more uniform teacher certification standards across the states.

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I want to thank all of our witnesses for their attendance this morning, and I look forward to our discussion on this important topic.

Mr. EHLERS. Thank you, Mr. Chairman. It is a pleasure to be here. Thank you for calling this hearing on my, one of my favorite topics.

Today's hearing will explore the recommendation of the National Science Board's recently-released report, "*A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System.*" That gives a very clear description of what we are talking about here, and it is an extremely important issue.

I understand that the report had its genesis as the Board was preparing the 2006, Science and Technology Indicators. The statistics on the state of science and engineering spurred the Board to create the commission to further explore the startling data on U.S. science and engineering education. I applaud the effort. This is an area I have been working in for many, many years, and this effort has resulted in the report before us.

The report has highlighted two grand challenges: coordination of STEM education efforts and improving teacher preparation. Both are extremely important. As the Academic Competitive Council report revealed, there are many federal STEM education efforts, but they suffer from a lack of both evaluation and coordination. Improving coordination is challenging, even just within the Federal Government, because each individual program has its merits. Expanding coordination of STEM education efforts to all levels is an incredible task that requires a "Sputnik-like" moment to unite everyone around a common goal.

Several public opinion reports have recently highlighted data showing that parents are not convinced that their kids must be skilled in math and science to survive in today's economy. Until we have that buy-in at the grassroots level, it will be hard for attempts at coordination to be sustained and successful.

A recent survey I believe highlights part of the problem when most parents replied that they thought math and science education in the United States should be improved, however, something like 80 or 90 percent believe that, but 70 percent thought that their kids' math and science program was absolutely fine. So once again there is a disconnect.

I am pleased to see that the Board has also recommended the establishment of national content guidelines, and I am heartened that the *Washington Post* recently reported that superintendents for Fairfax County and Montgomery County in two different states, Virginia and Maryland, believe that in order to properly assess stu-

dent achievement national content standards are needed. I have strongly supported national voluntary guidelines to help ensure that our mobile population receives a quality education, even if they change schools several times during their K–12 education. I emphasize the word, voluntary, because as you all know there is a strong feeling in the United States against mandatory federal standards for elementary and secondary education.

But I have introduced H.R. 325, the *SPEAK Act*, which would provide incentives for states to adopt voluntary standards in math and science. Co-sponsor on that is Senator Dodd. I know that this idea is controversial and look forward to learning from our witnesses about their views on this issue.

I trust this hearing will help Congress learn about the best ways we can advance the recommendations presented in the Board's report, and I thank our witnesses for being here today, and I especially thank those of you who have worked so hard and so long on this.

With that I yield back.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

Today's hearing will explore the recommendations of the National Science Board's recently-released report, "*A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System.*" I understand that the report had its genesis as the Board was preparing the 2006 Science and Technology Indicators. The statistics on the state of science and engineering spurred the Board to create a Commission to further explore the startling data on U.S. science and engineering education. I applaud the effort, which has resulted in the report before us.

The report has highlighted two grand challenges: coordination of STEM education efforts and improving teacher preparation. As the Academic Competitive Council report revealed, there are many federal STEM education efforts, but they suffer from a lack of both evaluation and coordination. Improving coordination is challenging, even just within the Federal Government, because each individual program has its merits. Expanding coordination of STEM education efforts to all levels is an incredible task that requires a "Sputnik-like" moment to unite everyone around a common goal. Several public opinion reports have recently highlighted data showing that parents are not convinced that their kids must be skilled in math and science to survive in today's economy. Until we have that buy-in at the grassroots level, it will be hard for attempts at coordination to be sustained and successful.

I am pleased to see that the Board has also recommended the establishment of national content guidelines, and heartened that the *Washington Post* recently reported that superintendents for Fairfax County (VA) and Montgomery County (MD) believe that in order to properly assess student achievement, national content standards are needed. I have strongly supported national voluntary guidelines to help ensure that our mobile population receives a quality education, even if they change schools several times during their K–12 education. Consequently, I have introduced H.R. 325, the *SPEAK Act*, which would provide incentives for states to adopt voluntary standards in math and science. I know that this idea is controversial and look forward to learning from our witnesses about their views on this issue.

I trust this hearing will help Congress learn about the best ways we can advance the recommendations presented in the Board's report and I thank our witnesses for being here today.

Chairman BAIRD. Thank you, Dr. Ehlers. If there are other Members who wish to submit additional opening statements, those will be added to the record at this point.

At this point I would like to introduce our witnesses very briefly.

Dr. Steven Beering is the Chairman of the National Science Board. Welcome, Dr. Beering.

Ms. Judy Jeffrey is the Director of the Iowa Department of Education, and she is here representing the Council of Chief State School Officers. Ms. Jeffrey.

Dr. Francis Skip Fennell is the President of the National Council for Teachers of Mathematics and a Professor of Education at McDaniel College in Westminster, Maryland. Doctor.

Ms. Chrisanne Gayl is the Director of Federal Programs for the National School Boards Association.

Dr. Robert Semper is the Executive Associate Director of the Exploratorium in San Francisco, and he is here today representing the Association of Science and Technology Centers.

And finally, Ms. Susan Traiman is the Director of Education and Workforce Policy for the Business Roundtable.

As our witnesses should know, spoken testimony is limited to five minutes. You will see on the desk there there is a little light box. If it starts getting yellow and it turns red, you have about five seconds to wrap up or a trap door disappears beneath your seat, and you are gone for a long time to come.

But we will start today with Dr. Beering. We are grateful for all of your perspectives and look forward to hearing from you. Thank you all for being here.

**STATEMENT OF DR. STEVEN C. BEERING, CHAIRMAN,
NATIONAL SCIENCE BOARD**

Dr. BEERING. Chairman Baird, Ranking Member Ehlers, Members of the Subcommittee, it is a pleasure to be with you again today and to speak to you about the Board's recently-released national Action Plan for addressing the critical needs of U.S. science and technology, engineering, and math education system. I am Steven Beering, Chairman of the National Science Board and President Emeritus of Purdue University. The Board appreciates the strong support and contributions to this plan by many Members of Congress, including several Members of this committee. We are delighted that you have chosen to gain additional comments and insights on the Action Plan from the important stakeholders and learned experts you have invited today to provide testimony.

We are all aware of the poor performance of American students in international assessments at the high school level. Our students, the future leaders, citizens, and workforce of our nation, must achieve to high standards and perform better relative to their international peers. Otherwise, it will be quite difficult for the U.S. to develop the future mathematicians, scientists, and engineers needed for the Nation to continue to lead the world in innovation.

The Board developed this Action Plan beginning in December of 2005, with a hearing right here on Capital Hill. This was followed by Board hearings in Boulder, Colorado, and Los Angeles, California. In March of '06, the Board created a federal advisory committee. We called it the Commission on 21st Century Education and STEM to provide advice to the Board.

We are grateful for the significant contributions of the members of this Commission whose solid advice and recommendations contributed importantly to this plan. The Commission's draft report given to our Board in March of '07, is appended in its entirety to the Board's Action Plan, along with a list of the Commission's

membership. Altogether more than 90 experts provided input to the Action Plan, either by serving on the Commission itself or one of its working groups who are testifying before either the Board or the Commission.

In August of '07, the Board released a draft version of our national Action Plan for public comment and received nearly 100 responses. These comments were gratifyingly and overwhelmingly positive. Many respected reports on STEM education have been published by well-qualified experts over the past two and a half decades. With this Action Plan, the Board has built on those reports and prioritized the most important actions that can be taken by Congress and others in order to make a significant impact on STEM education in the Nation.

I would like to highlight the two major recommendations in the Board's plan. These are, number one, insuring coherence in the Nation's STEM, education STEM, and number two, insuring an adequate supply of well-prepared and highly-effective STEM teachers.

The Board has concluded that horizontal coordination of STEM education is needed among states and vertical alignment among components of the system from pre-kindergarten through college. A coordinated system of STEM education means that a student who starts kindergarten in Kansas, attends middle school in California, and enters high school in Illinois will have the opportunity to master the foundational skills needed for future success and more advanced STEM studies and which are increasingly needed in the workforce.

The first step towards greater coherence, Federal Government departments and agencies should coordinate their own STEM education through the Office of Science and Technology Policy.

Second, we recommend that a new executive position, perhaps an assistant secretary, be created within the Department of Education, to coordinate the Department's own STEM programs and to serve as the focal point for contact between the Department and other stakeholders.

Finally, and most critically, the Board recommends that Congress charter a new, independent, non-federal national body or council for STEM education that would serve as the primary vehicle for facilitating coordination among all those involved in STEM education.

STEM education activities or federal agencies should be coordinated with State and local activities through this national council. This entity would also facilitate and help to sustain horizontal coordination among states and vertical alignment across grade levels.

The Board's second recommendation for STEM education previously expressed in a range of Board statements and reports over the last quarter century is targeted to the development and retention of a high-quality STEM teaching workforce and profession.

We recognize and congratulate Congress on the valuable contributions in this area made by the America COMPETES Act. A number of the Board's recommendations are already addressed by this Act. What America needs today is the individual and collective recognition and resolve to compete globally.

In conclusion, our Action Plan addresses the need to take national action now, involving all stakeholders and all levels of gov-

ernment. In particular, we urge serious consideration by Congress of the need for increased and sustained coordination of STEM education-related activities. We recommend especially the creation of an independent and non-federal National Council of STEM Education to bring together all stakeholders to achieve our mutual goals.

Thank you for inviting me to testify before you today and for the long-term, strong support by Congress and this committee for education and research and science technology, engineering and mathematics. I will be happy to address your questions.

[The prepared statement of Dr. Beering follows:]

PREPARED STATEMENT OF STEVEN C. BEERING

Chairman Baird, Ranking Member Ehlers, Members of the Subcommittee, it is a pleasure to speak to you today about the National Science Board's recently released *National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System* (NSB-07-114). I am Steven C. Beering, Chairman of the National Science Board and President Emeritus of Purdue University. The Board appreciates the strong support and contributions to this plan by several Members of this committee.

The Board feels that science, technology, engineering, and mathematics (STEM) education is of critical importance to the Nation and is delighted that this Committee has chosen to gain additional comments and insights on the Action Plan from the important stakeholders and learned experts you have invited to also provide testimony today. In this written testimony I will first describe the process for developing the Board's Action Plan, summarize the main points of the Action Plan, and then describe the public comments received by the Board on a draft version of the Action Plan. I have attached as supplemental excerpted statements from select governors.

Process for Developing the Action Plan

The development of this Action Plan has been a long and systematic process for the Board, beginning in December 2005 when the Board held the first of three hearings on what actions could be taken to improve K-12 science, technology, engineering, and mathematics (STEM) education in the Nation on Capitol Hill. The Board held two more hearings in February and March 2006 in Boulder, Colorado and Los Angeles, California. A list of those who testified at the Board hearings may be found in Appendix C of the Action Plan.

In March 2006 the Board established a federal advisory committee to the Board, the Commission on 21st Century Education in Science, Technology, Engineering, and Mathematics. The Charge to the Commission and its membership are listed in Appendices D and E, respectively, of the Action Plan. The Commission presented a draft report to the Board in March 2007, which is included as Appendix F of the Action Plan, including a list of those who testified before the Commission or were on one of its working groups.

The Board developed its National Action Plan based on all this input. I personally chaired the hearings the Board held and attended nearly all of the meetings of the Commission. All together, more than 90 experts provided input to the Action Plan either by serving on the Commission or one of its working groups or testifying before either the Board or the Commission. In addition, Dr. Michael Crosby, National Science Board Executive Director, and Dr. Elizabeth Strickland, from our Board Office staff held more than two dozen meetings with various stakeholders to gather input to the Action Plan.

In August 2007 the Board released a draft version of its Action Plan for public comment and received nearly one hundred valuable and overwhelmingly positive that I will summarize later in this testimony. A list of those who provided public comments is included in Appendix G of the Action Plan.

Summary of Action Plan

Addressing the shortcomings of the Nation's STEM education system is absolutely essential to the continued economic success of the Nation and to its national security. It is essential that *all* American citizens have the necessary scientific, technological, and mathematical knowledge and skills to make informed personal choices and voting decisions and to thrive in the current technologically rich, global marketplace. In 2003, 18 countries out of 29 countries outperformed the United States in

the science literacy of 15-year-olds on the OECD's PISA test. American students must achieve to higher standards and perform better relative to their international peers. Unless there is a broad pool of K–12 students with a solid foundation in STEM disciplines, it will be very difficult for the U.S. to develop the future mathematicians, scientists, and engineers needed for the Nation to continue to lead the world in innovation—an issue that the Board plans to address in the upcoming year.

Many respected reports on STEM education have been published by well-qualified experts over the past two and a half decades. What is immediately apparent when one reviews these reports is that, tragically, many of these reports had excellent recommendations for actions that were never implemented.

In developing this Action Plan, the Board has attempted to prioritize the most important actions that can be taken by Congress and others in order to make a significant impact on STEM education in the Nation. These actions are not, of course, the only actions that could—or even should—be taken to improve STEM education. Rather, the intent of the Board in this Action Plan is to call out a few critical actions that are absolutely essential for significant gains in STEM education in the Nation.

In order to move STEM education forward in the Nation, the Board believes that two major issues must be addressed—ensuring coherence in the Nation's STEM education system and ensuring an adequate supply of well-prepared and highly effective STEM teachers.

The Nation requires a coordinated system of STEM education. There is a need for both horizontal coordination of STEM education among states and vertical alignment among components of the system, from pre-kindergarten through college. A coordinated system of STEM education means that a student who starts kindergarten in Kansas, attends middle school in California, and enters high school in Illinois will have the opportunity to master the foundational skills needed for future success in the workforce and higher education.

Second, the Nation requires a supply of well-qualified, highly effective, and well-supported teachers. Teachers, as you are well aware, are critically important to student learning in the classroom, and we must make serious efforts to attract top-quality teachers into the classroom in STEM disciplines, ensure their preparation for teaching STEM content is thorough, and effectively support them while they are in the classroom.

First, the Board strongly feels that increased coordination of STEM is essential for significant improvements to be made. Coordination should occur both across the Federal Government and among the Federal Government and all stakeholders including, in particular, local and State education agencies and institutions of higher education. The Board is well aware that local and State governments bear the ultimate responsibility in the Nation's public education system and does not challenge this role. The actions being proposed by the Board are intended to provide mechanisms for the Federal Government to better support local and State efforts and for local and State education agencies to interact effectively with each other and other stakeholders in addition to the Federal Government.

I will not describe in detail all the recommendations in the Action Plan for this coordination, but rather highlight, briefly, the four places where the Board feels coordination should occur.

First, without question, the Federal Government must do a better job of coordinating its own STEM education activities. The Academic Competitiveness Council report that inventoried federal STEM education programs for fiscal year 2006 put the spending total for all agencies at more than \$3 billion scattered across 100—some programs—approximately \$575 million of which was for K–12 programs. To maximize the effectiveness of this spending and these programs, the Board's recommendation is that all federal agencies coordinate their STEM education efforts through the National Science and Technology Council (NSTC) within the Office of Science and Technology Policy in the Executive Office of the President. The Board recommends that given the importance of this issue a full committee on STEM Education be created within the NSTC.

Second, given the clear, important role that the Department of Education plays in STEM education, the Board recommends that a new Assistant Secretary position be created within the Department of Education to coordinate STEM programs within the Department and to serve as the focal point for those outside the Department to interact with the Department on STEM education issues.

Third, much direction is given in the Action Plan to the specific responsibilities of the National Science Foundation toward STEM education in the Nation and how it should be prioritizing and focusing its own activities and partnering with other federal agencies.

Finally, and perhaps most importantly, the Board recommends the creation of something that does not currently exist and is without precedent—a National Council for STEM Education. The Board recommends that Congress charter a new, non-Federal National Council for STEM Education that would coordinate among all those involved in STEM education, not just those at the federal level. Potential members of the Council are shown here. The Council would be made up of representatives from local and State governments and organizations, professional STEM educators, the business community, higher education, private foundations, STEM disciplinary societies, informal STEM education, and other stakeholders. The Federal Government would be represented on the Council through representatives from the NSTC Committee on STEM Education that I described earlier. The role of the Council would be to coordinate among all its members to ensure that STEM education in the Nation moves forward. A detailed list of proposed responsibilities may be found in the Action Plan text.

Now that I have described the “who” of the recommendations for increased coordination, I briefly describe the Board’s vision for a coherent national STEM education system.

The Board’s Action Plan recommends that all stakeholders work together through the National Council for STEM Education to ensure horizontal coordination among states and vertical alignment across grade levels. This is particularly important in our highly geographically mobile society. A 2004 Census Bureau report estimates that 15 to 20 percent of school-aged children moved in the previous year, and a 1994 GAO study reported that one out of six students had attended three or more schools by the end of third grade. In this context, coordination of STEM learning, which requires the systematic building of a knowledge base, is critical. Details of each of these aspects may be found in the text of the Action Plan. Briefly, however,

The Board recommends that all stakeholders work together, using the National Council for STEM education to provide horizontal coordination of STEM education among states by:

- Facilitating a strategy to define national STEM content guidelines that would outline the essential knowledge and skills needed at each grade level;
- Developing metrics to assess student performance that are aligned with national content guidelines;
- Ensuring that assessments under No Child Left Behind promote STEM learning; and
- Providing a forum to share and disseminate information on best practices in STEM teaching and learning.

Additionally, the Board recommends that all stakeholders promote vertical alignment of STEM education across grade levels—from pre-kindergarten through the first years of college by:

- Improving the linkage between high school and higher education and/or the workforce; and
- Creating or strengthening STEM education-focused P–16 or P–20 councils in each state.

Finally, the Board feels strongly that serious national attention must be focused on attracting, preparing, and retaining qualified and committed teaching candidates. The Board recognizes that much was done in the *America COMPETES Act* to support STEM teacher preparation and we are supportive of that. STEM educators should be viewed as a valuable national resource, and the best and the brightest should be encouraged to consider pre-college STEM teaching as a profession. Accordingly, the Board recommends:

- Developing strategies for compensating STEM teachers at market rates;
- Providing resources for the preparation of future STEM teachers;
- Increasing STEM teacher mobility between districts by creating national STEM teacher certification standards; and
- Preparing STEM teachers to teach STEM content effectively.

Although all stakeholders must work to address shortages in the STEM teacher supply, this is an area where institutions of higher education must play a large role and communication must increase among community colleges and four year institutions and among schools of education and colleges of arts and science and schools of engineering.

To summarize, this Action Plan lays out a structure that will allow stakeholders from local, State, and Federal governments, as well as non-governmental STEM

education stakeholder groups, to work together to coordinate and enhance the Nation's ability to produce a numerate and scientifically and technologically literate society and to increase and improve the current STEM education workforce.

Summary of Public Comments

The Board received more than 100 public comments on the Action Plan. The comments came from a broad range of stakeholders—states, K–12 teachers, disciplinary societies, university faculty and administrators, mathematicians, scientists and engineers, various organizations, and parents.

Overall the comments were positive with a number noting their gratitude for the Board's willingness to address this topic.

The dominant themes that emerged from the comments were:

- (1) General support for the National Council for STEM Education, but suggestions for ways that the Council could be structured slightly differently. These included increasing the level of staff support to accomplish the Council's mandate, including additional specific groups, and suggesting alternate ways the initial members of the Council could be appointed. A few raised the concern that the Council could become ineffective bureaucracy.
- (2) Concern that disciplinary societies (and national labs) were given an inadequate role in the draft Action Plan.
- (3) General support for the draft Action Plan statements on increasing STEM teacher compensation.
- (4) Many comments related to a need for a sea-change in public perception of STEM fields and student interest in these. There were many recommendations for increased emphasis for this in the draft Action Plan and for the need for a public campaign to raise the profile of STEM fields.
- (5) Concern that technology, engineering, and mathematics are not adequately emphasized and that the draft Action Plan was really more about science than the other disciplines. A repeated concern raised was that technology and engineering skills are in particular demand in the 21st century.
- (6) Regarding national content guidelines there was a mix of opinions about the merit of this and concerns about unintended consequences of the implementation.
- (7) Concern that not enough responsibility was assigned to the colleges of arts and sciences and engineering to be collaborating with colleges of education to prepare STEM teachers.

The revisions made to the draft Action Plan in response to the public comments were adjustments to the language and emphasis of sections of the Action Plan rather than a significant restructuring of the Action Plan recommendations.

Concluding Statements

In releasing this National Action Plan, the Board is making a statement that it feels action must be taken on STEM education now. To be frank, the United States cannot afford to let the status quo of STEM education in the Nation continue. If this critically important, yet often disregarded, issue is not addressed, my grandchildren and the generations that follow will not have the same opportunities for world leadership in STEM and standard of living as those of us serving on the Board today have enjoyed.

Many of the recommendations in the Board's Action Plan—particularly related to STEM teacher preparation—are consistent with items in the *America COMPETES Act* that Congress passed and the President signed into law in August. Congress is to be congratulated for the bold steps taken there.

The Board is in agreement that although many of the steps already taken by Congress and underway in many states through the leadership of Governors are extraordinarily valuable and important, without a focal point for coordination, these scattered programs likely will not be able to effect a large change in the Nation's overall STEM education system. The Board is convinced that the recommendations made in the Action Plan for increased coordination of STEM education and, in particular, the creation of an independent and non-federal National Council for STEM Education to bring together all stakeholders must be given serious consideration by Congress.

National Science Board

Excerpted Statements Regarding the National Science Board's STEM Education Action Plan[†]

Governor Linda Lingle, State of Hawai'i

"We recognize that emphasizing science, technology, engineering and math (STEM) education in Hawai'i and across the nation is essential to the United States competing and leading in a rapidly changing world and increasingly competitive global economy... For this reason, the State of Hawai'i endorses the new National Action Plan for STEM Education created by the National Science Board... It is clear that the vision laid out in the National Action Plan is the path that will lead the United States to a brighter and more prosperous future. I am particularly happy the National Action Plan's focus continues to be on providing future generations with a STEM education that provides the technical savvy, problem solving skills and capacity for innovation needed to raise our quality of life and lead our country forward in the 21st century and beyond."

Governor Joe Manchin III, State of West Virginia

"The National Science Board's action plan provides a well-reasoned and comprehensive strategy for meeting America's urgent STEM education needs. The credibility and expertise of the NSB and the members of the Commission on 21st Century STEM Education assure that the plan will be read carefully and taken seriously. In addition to the recommendations for federal action, I am pleased that the report also recognizes the key role of state governments and state-level entities, such as P-16 councils, in helping to implement this plan. Every state has important contributions to make to the overall national effort in STEM education."

Governor Jim Doyle, State of Wisconsin

"It is increasingly clear that strong mathematical and scientific skills are crucial to ensuring that our students are able to compete for jobs in an ever more global economy. I believe the work of a National Council for STEM Education would be very valuable for the state of Wisconsin and the nation... An organization to provide guidance and coordination to the flow of STEM education would allow states to make decisions more efficiently and provide teachers with the best tools for quality STEM education. Resources such as reports, research- and evidence-based best practices and models, and databases of grant or funding opportunities would be invaluable to states, school districts, and teachers... this action plan will push our nation toward excellence in the global marketplace."

Dr. Nancy S. Grasmick, State Superintendent of Schools, Maryland

"The guidance provided in this action plan will surely help Maryland and every other state provide a cohesive science, technology, engineering, and mathematics education for our students to meet [the international] competitiveness challenge."

[†] Complete statements available from the National Science Board Office on request.

BIOGRAPHY FOR STEVEN C. BEERING

Steven C. Beering received B.S. and M.D. degrees and an honorary Doctor of Science degree from the University of Pittsburgh. Before becoming President of Purdue in 1983, he served for a decade as Dean of Medicine and Director of the Indiana

University Medical Center. He holds appointments as professor of medicine at Indiana University and professor of pharmacology at Purdue University. He retired from the Purdue presidency in 2000.

He served on active duty with the USAF Medical Corps from May 1957 to June 1969, achieving the rank of Lieutenant Colonel.

Beering has held numerous national offices, including the chairmanship of the Association of American Medical Colleges and the Association of American Universities. He is a former regent of the National Library of Medicine.

He is also a Fellow of the American College of Physicians and the Royal Society of Medicine, a member of Phi Beta Kappa, the Institute of Medicine of the National Academy of Sciences, and the Indiana Academy.

He serves on a number of national and corporate boards, including NiSource Inc., Central Indiana Corporate Partnership, Inc., Community Foundation of Northern Indiana, CID Corporation, and Marquis Who's Who. He is a Trustee of the University of Pittsburgh, and the Universities Research Association, and is Director Emeritus of the Purdue Research Foundation.

Beering was appointed to the National Science Board in 2002, reappointed in 2004, and elected Chairman in 2006.

STATEMENT OF MS. JUDY A. JEFFREY, DIRECTOR, IOWA DEPARTMENT OF EDUCATION, REPRESENTING THE COUNCIL OF CHIEF STATE SCHOOL OFFICERS

Ms. JEFFREY. Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you. I am testifying today on behalf of the Chief State School Officers and in my capacity as Director of Education for the State of Iowa. I was also the co-chair of a recently-related report from CCSSO regarding math and science education.

I appreciate the opportunity to provide a State perspective on the Action Plan. I can tell you that the Chief State School Officers are playing a key role within our respective states to improve science and mathematics education.

This is a very high priority for us, and although each state may be approaching the situation in a little different way, all believe strongly that STEM education must be a high priority for us. States have the responsibility for guiding and leading the local school districts in raising student expectations, providing rigorous and relevant curriculum, and helping determine appropriate and instructionally-helpful assessment techniques.

In Iowa we have developed rigorous and relevant curricular expectations in math and science with accompanying model lessons and units to assist our teachers in developing higher-level thinking and deepen students' learning. We have expanded the number of middle school and high school sites to implement a pre-engineering curriculum entitled, "Project Lead the Way."

I know from personal experience in Iowa, along with other states, we are concerned about recruiting and retaining math and science teachers. At a time when the Nation and many states need more engineers, we also need more math and science teachers. I appreciate and commend the report on the recommendation to increase STEM teacher compensation and improve human capital.

States are also busy aligning expectations from pre-K through 16 by working with business and higher education and considering their own initiatives to improve articulation, establish consistent expectations, and expand educational opportunities for practicing teachers.

States do need help from the Federal Government, and I agree with the report's recommendation that better coordination is needed among all federal departments and agencies involved in STEM education research and programs.

State departments of education face competing requirements and priorities from different STEM education programs and efforts, so this recommendation is a step in the right direction to streamline federal programs.

The last thing, frankly, we need right now as we race to compete is more bureaucracy. What I need the most right now to help improve STEM education is the emphasis in the Action Plan to provide and communicate research on STEM education. As our teachers work with struggling students and those who do not believe they can master math and science, we need the most up-to-date research on how we can better motivate and engage students in rigorous and relevant learning.

Funding that assists a state to implement innovative models and actions to engage students' minds and their willingness to pursue math and science careers is much more helpful than more bureaucratic processes or directives.

Iowa's high school reform efforts are focusing on creating teaching approaches that develop authentic, intellectual work on the part of the students and teaching strategies that engage students in relevant and meaningful tasks and high-level skills.

Some specific concerns I have with the STEM Education Council is the Council's charge to develop STEM's content guidelines. This effort may easily be perceived as a creation of national content standards. Since a large number of states and localities are not involved in the decision-making process, the Council will not have as much buy-in as is needed for this type of initiative.

I do believe the Council is not the appropriate vehicle for the creation of National STEM content standards. Instead, of national content standards the Council could develop cross-cutting, integrative areas that move the discussion to what the intent of STEM education should be. We must embed the mathematics, science, and technological skills required of world-class students across the disciplines and within the career and technical programs and areas.

Our needs are great, but it does not lie in more rules, more reports, and more oversight. Each teacher deserves high-quality, ongoing, and on-the-job professional development in researched-based instructional strategies. Incentives from the Federal Government to assist states to implement innovative programs and practices to raise math and science achievement might just provide some of the keys to unlock America's student human potential.

What better way for American's education system to take a front-end, center stage to raise our sights high but engaging our educator's human spirit and desire to improve student learning. There is much to do. We are not interested in duplicate work that is already proceeding, nor should we hinder our efforts to improve.

Streamlining federal work, helping states in their work, and providing incentives for innovation would be welcomed by me and my colleagues.

Thank you, and I look forward to any questions you might have.
[The prepared statement of Ms. Jeffrey follows:]

PREPARED STATEMENT OF JUDY A. JEFFREY

Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you for the opportunity to testify today regarding the National Science Board's (NSB) Action Plan for science, technology, engineering, and math (STEM) education. I am testifying today on behalf of the Council of Chief State School Officers (CCSSO) and in my capacity as the Director of the Iowa Department of Education. I was also the Co-Chair of the Council's Math and Science Education Task Force in 2006.

Thank you for inviting me to provide a State perspective on the NSB Action Plan. States play a key role in developing our nation's STEM education system and have put considerable energy and resources into improving it. Just in the last year, Iowa developed new rigorous and relevant curricular expectations in science, expanded Project Lead the Way accessibility, and implemented a public-private partnership related to STEM professional development for teachers.

First, I would like to comment on the positive steps the NSB Action Plan is taking. The report rightly addresses State responsibility for STEM education and appropriately places emphasis on the critical need to recruit STEM teachers and develop their skills. I also agree with the report's recommendation that better coordination is needed among all federal departments and agencies involved in STEM education research and programs. State departments of education face competing requirements and priorities from different STEM education programs, so this recommendation is a step in the right direction to streamline federal programs. The Action Plan places needed emphasis on the Federal Government effectively providing and communicating research on STEM education, which is a priority for CCSSO and one of our recommendations for the reauthorization of the *Elementary and Secondary Education Act (ESEA)*.

My fellow chief State school officers and I support coordination on STEM education among states and national organizations since we learn from sharing our experiences and ideas and adopting successful practices from other states. In fact, recommendations from our Math and Science Education Task Force emphasize working with national organizations to enhance curricula, instructional materials, and the STEM education movement more broadly. We also believe that a state has the responsibility to align P-16 expectations, curriculum, and licensing requirements to ensure that the State systems are aligned, to not only create the most powerful opportunities for students but also to ensure smooth transitions of students. States across this nation are already engaged in this work.

The national STEM education council seeks to increase collaboration and coordination among stakeholders; however, the council runs the risk of creating another level of bureaucracy rather than moving the conversation on STEM education forward. States are already taking many steps on their own to build our students' knowledge of science, technology, engineering, and math and align high school with college and work expectations. These efforts should receive support from the Federal Government so promising work can be expanded. Funding that assists a state to implement innovative models and actions to engage students' minds and their willingness to pursue math and science careers is much more helpful than more bureaucratic processes or directions. Iowa's high school reform efforts are focusing on creating teaching approaches that develop authentic intellectual work on the part of the students and teaching strategies that engage students in relevant and meaningful tasks and high level skills.

There are other specific concerns I have with the STEM education council. The council's charge to develop STEM content guidelines may easily be perceived as creation of national content standards. Since a large number of states and localities are not involved in the decision-making process, the council will not have as much buy-in for this initiative. The council may not be an appropriate vehicle for creation of national STEM content standards. Instead of national content standards, the council could develop crosscutting, integrative areas that move the discussion to what is the intent of STEM education. We must embed the mathematics, science, and technology skills required of world class students across the disciplines and within the career and technical courses. Also, one of the responsibilities of the council is to create a regular report on STEM education in states and the Nation. This may not be the best use of time and funds for the council since there is no clear value in producing another report unless it truly helps states and districts improve their policies.

Changes to STEM education cannot be considered without acknowledging the current accountability environment states and districts encounter under NCLB, which can provide a disincentive to deep, meaningful change in STEM education. Also, as the NSB Action Plan acknowledges, assessments must match State standards to

have a significant impact. If State standards require students to demonstrate problem-solving skills and apply their knowledge to real world situations, then assessments must do the same. Funding and support from the Federal Government to create better assessments has not been adequately provided in the past. The report recognizes the importance of assessment and that states should enhance their math and science assessment systems. However, the Action Plan does not address how states would deal with the cost and amount of time it takes to produce these more complex assessments. I believe that the Federal Government could play a role in supporting states' development of assessments that require high-level thinking and are also designed to provide feedback to teachers that they can use to improve instruction. Iowa is fortunate to have several companies that are "experts in assessment" in our backyard. But, the types of assessments being discussed are expensive. States simply do not have the resources currently to develop assessments that measure what is truly meaningful to measure. At the same time we must consider where limited funds can best be spent. I would prefer investing in improving the quality of teaching.

This takes me to another topic with great focus in the report: professional development. It is a key way that we can improve STEM education since we must change what occurs in our classrooms if we want to see changes in student learning. To build on the Action Plan's recommendations around professional development, there should be greater emphasis on communicating to education leaders and teachers what quality really means in professional development and the knowledge and skills STEM teachers need to be effective. On-going, in-depth, on the job professional development will hold the greatest promise of improving teaching and learning. Pre-service programs must also incorporate STEM learning for elementary school classroom teachers, who are often young children's primary science educators. The Action Plan should acknowledge the need for prospective elementary school teachers to receive challenging math and science content and pedagogy or course work in their teacher preparation programs.

Overall, I am pleased to see that the National Science Board's Action Plan for STEM education recognizes the leadership of states and districts on STEM education issues and seeks to enhance collaboration and communication between all STEM stakeholders. The Federal Government should play a role in improving STEM education by increasing coordination among federal agencies and programs and supporting and communicating more STEM education research that is useful to educators and policy-makers. The Federal Government needs to provide assistance to states and districts to develop and expand innovative programs on STEM education. We look forward to continuing our dialogue with you about ways to improve student learning in science, technology, engineering, and math education.

Thank you. I look forward to any questions you may have.

BIOGRAPHY FOR JUDY A. JEFFREY

Judy Jeffrey was appointed Director of the Iowa Department of Education in November 2004. In this role, she provides leadership and supervision for an educational system that includes 520,000 students in public and private accredited K-12 schools; 115,000 credit students in 15 community colleges; and 3,500 employees in 10 area education agencies. Before serving as Director, Judy Jeffrey had been the state's Early Childhood, Elementary & Secondary Division Administrator since 1996.

Before that, she served 24 years in the Council Bluffs Community School district in various administrative and classroom teaching positions. Jeffrey also has been an instructor at Creighton University, and has taught in other Iowa districts including Cedar Falls and Goldfield, where she began her teaching career.

She was President of the Council of Chief State School Officers Deputy Commission from 2001-2003, and currently is a member of the Chief State School Officers. Jeffrey earned her Bachelor's degree from the University of Northern Iowa, her Master's degree from Creighton University and postgraduate work at the University of Nebraska at Omaha.

Chairman BAIRD. Thank you very much. We have been joined by the distinguished gentleman from Texas, Mr. Hall, and by Dr. McNerney from California and by Dr. Lipinski as well. Thank you all.

Dr. Fennell.

**STATEMENT OF DR. FRANCIS (SKIP) FENNELLS, PRESIDENT,
NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS**

Dr. FENNELLS. Good morning, Chairman Baird and Congressman Ehlers. My name is Francis "Skip" Fennell. I am a Professor of Education at McDaniel College in Westminster, Maryland. Today I am here as the President of the National Council of Teachers of Mathematics. At this time I will be highlighting elements of the testimony that you have received.

First, thank you for the opportunity to speak with you about the National Science Board's National Action Plan for STEM education. NCTM believes that creating a coherent STEM curriculum and placing a well-qualified, highly-effective teacher in every STEM classroom are critical goals for this efforts. Creating an independent national council for STEM education can reestablish the sustained critical focus in education that was the hallmark of this country's success in response to the launch of Sputnik 50 years ago.

Implementing all aspects of the National Science Board's National Action Plan for addressing the critical needs of the U.S. science, technology, engineering, and mathematics education system could produce significant, and more importantly, enduring changes in STEM education.

NCTM especially supports those recommendations that acknowledge the need for more and better STEM teachers. Time and ago research has shown that the most important factor in student achievement is the quality of the teacher. All teachers must understand how students learn. Highly-qualified teachers of mathematics not only understand but also invest in the particular culture of their students and school, and they must actively engage students of diverse backgrounds and strengths in significant and challenging mathematics.

The creation of an assistant secretary of STEM education at the Department of Education would bring much needed coordination among the numerous existing programs that address STEM education, and the formation of a new, independent, non-federal national council for STEM education to coordinate programs nationwide would raise the profile and importance of STEM education and development.

We also believe that a coherent STEM education roadmap can be defined through the combined efforts of the National Science Foundation and the Department of Education. We strongly encourage capitalizing on the work that is currently being done on learning and educational practices of the National Science Foundation. This work can augment and improve instructional practice and student learning, topics which are currently being examined by the National Mathematics Panel of which I am a member.

As the Board noted, one of the most significant challenges facing the STEM fields and mathematics education is a lack of curricular coherence. Curricula today are dominated by long lists of very specific learning expectations. How does a teacher, typically a generalist, at the elementary school level identify what is most important at the fourth grade level and try to deal with that common, perhaps tiring, criticism that our curriculum is a mile wide and an inch deep. Greater curricular coherence is needed horizontally among states and vertically across grade levels.

In 2006, the National Council of Teachers of Mathematics addressed the coherence issue with the publication of, "Curriculum Focal Points for Pre-kindergarten through Grade Eight Mathematics: A Quest for Coherence." The focal points describes the most significant mathematical concepts and skills for each grade level and presents a way to organize and connect critical mathematics topics from grade to grade.

The focal points build a foundation for higher-level mathematics beginning with algebra. Curriculum focal points present the framework to guide states and school districts as they design and organize their expectation and assessments. They are intended to frame discussions that will eventually guide textbook publishers and assessment developers as well. The focal points answer the question: What are the key mathematical ideas or topics on which the others build? Another mathematics panel topic, the goal is for the focal points to be used in the development of mathematics curriculum goals that are more cohesive from grade to grade and from school to school, and with a high rate of mobility in this country, dare I say, from state to state.

This process has begun. NCTM has made presentation to work with more than 20 States, including Oregon and Maryland. They are now using the focal points to assist them as they revise State standards and assessments.

Finally, I would be remiss if I didn't address an element of a child's education that is often overlooked. As the National Science Board and other prominent education leaders have noted, a child's first and perhaps most influential teacher is a parent. Any call to action must recognize the critical role that families play in encouraging children and exposing them to knowledge and ideas about any topic or subject, including mathematics. This does not mean that all parents have to solve all the problems, know all the answers, but they must value the importance of this subject.

In closing, and I cannot tell you how pleased and excited I am about the attention that mathematics and the STEM disciplines are receiving. The COMPETES bill, the NSB's plan and discussions about changes to the *Elementary and Secondary Education Act* are the fruits of years of effort to bring about change, and I look forward to seeing where it takes mathematics education and more importantly, our nation's students.

Thank you very much for this opportunity. I look forward to your questions.

[The prepared statement of Dr. Fennell follows:]

PREPARED STATEMENT OF FRANCIS (SKIP) FENNELL

Good morning, Chairman Baird and Congressman Ehlers. My name is Francis (Skip) Fennell. I am a Professor of Education at McDaniel College in Westminster, Maryland. I am here today as President of the National Council of Teachers of Mathematics (NCTM).

First, thank you for the opportunity to speak with you about the important effort undertaken by the National Science Board to develop a national action plan for STEM education. NCTM believes that creating a coherent STEM curriculum and placing a well-qualified, highly effective teacher in every STEM classroom are critical goals for this effort. In a national system where every local school board is empowered to decide what is taught and who does the teaching in every classroom, there are daunting, but not insurmountable, challenges to achieving these goals. By establishing an independent National Council for STEM Education, we can re-establish the sustained critical focus in education that was the hallmark of this great

country's success in response to the launch of Sputnik 50 years ago. We support the creation of a national council and are optimistic that it would develop an agenda that would identify and address the issues that would make a meaningful difference in student learning. The National Council of Teachers of Mathematics is very willing and eager to support this effort.

Before I turn to NCTM's comments on the report, I would like to address an element of a child's education that is often overlooked by policy experts and elected officials. As members of the National Science Board and other prominent education leaders have noted, a child's first—and perhaps most—influential teacher is a parent. Any call to action—small or large—must recognize the crucial role that parents play in encouraging children and exposing them to knowledge and ideas about any topic or subject, including mathematics. Without parental support and involvement, it will be very difficult to convince young people of the urgency and importance of STEM literacy in this country.

Just as parents must do their part, educators and lawmakers must do what we can to reach beyond the “best and brightest” students, lending tangible support and extending viable options to *all* young people throughout our K–12 system. And it is important that we truly reach all students and meaningfully address the persistent problem of achievement gaps in education. This is a challenge for all of us involved in education, and it is one that we must continually address in all its forms.

The NSB STEM Action Plan

As you know, in August the National Science Board released a draft of what is now its final report, *“A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System.”* NCTM submitted a number of comments, expressing support for the overall intent of the plan and, in general, its recommendations. Implementing all aspects of the plan could produce significant—and, more important—enduring, change in STEM education, laying the foundation for high academic achievement in STEM fields in the future and providing all students with the knowledge required to be successful, productive citizens.

NCTM especially supports those recommendations that acknowledge the need for more and better STEM teachers. Time and again, research has shown that the most important factor in student achievement is the quality of the teacher. We endorse all efforts to ensure that students are taught by well-qualified and highly effective teachers. We strongly support offering resources for their academic preparation, increasing STEM teacher mobility between districts by creating national STEM teacher certification standards, and preparing STEM teachers to teach STEM content effectively.

It is the position of the Council that every student has the right to be taught mathematics by a highly qualified teacher—a teacher who knows mathematics well and who can guide students' understanding and learning. A highly qualified teacher understands how students learn mathematics, expects *all* students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning.

All teachers must understand how students learn mathematics. They must know how to plan, conduct, and assess the effectiveness of mathematics lessons. In addition, they must listen and question, knowing how and when to make important teaching decisions. Highly qualified teachers of mathematics not only understand, but also invest in, the particular culture of their students and school. They dedicate time and energy both inside and outside the classroom. And they are adept at actively engaging students of diverse backgrounds and strengths in significant and challenging mathematical tasks that help them understand concepts, learn skills, and solve problems.

The creation of an Assistant Secretary of STEM Education at the Department would bring much-needed coordination among the numerous existing programs that address STEM education. And the formation of a new, independent, non-federal National Council for STEM Education to coordinate programs nationwide would raise the profile and importance of science, mathematics, engineering, and technology education and development.

Finally, we believe that a coherent “STEM education roadmap” can be defined through the combined efforts of the National Science Foundation and the Department of Education. Working together and drawing on the findings and expertise of other agencies and organizations in the education and scientific communities, these partners can attain this goal, and its achievement will support and serve STEM education well. We strongly encourage capitalizing on the work that is currently being accomplished on learning and educational practices by the National Science

Foundation. This work can augment and improve current instructional practice and student learning.

The forthcoming work of the National Mathematics Advisory Panel should also provide guidance on the future for mathematics education. The panel's report, which will be published and released in February, continues to emphasize the importance of research on the teaching and learning of mathematics and the need for high-quality teachers and curricular coherence, through findings that are reinforced by research.

NCTM's Curriculum Focal Points

As the Board noted in its report, one of the most significant challenges facing STEM fields and mathematics education is a lack of curricular coherence in the early grades. Today's mathematics curricula tend to be dominated by long lists of very specific goals, standards, objectives, or learning expectations, which present teachers with a formidable challenge. How does a teacher identify what is most important and address the common criticism that our curriculum is "a mile wide and an inch deep?"

The impact of this lack of curricular coherence is felt in many ways. For example, student mobility is much greater today than in the past, and it continues to increase. More and more students are changing schools, and frequently they must adapt to a completely different curriculum as a result. Greater curricular coherence is needed horizontally, among states, and vertically, across grade levels.

In 2006, the National Council of Teachers of Mathematics addressed this issue with the publication of *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence*. *Curriculum Focal Points* describes significant mathematical concepts and skills for each grade level. It presents a way to organize and connect critical mathematics topics from grade to grade. Focal Points are the related ideas, concepts, skills, and procedures that form the foundation for understanding, lasting learning, and success in higher-level mathematics, beginning with algebra.

Curriculum Focal Points presents a focused framework to guide states and school districts as they design and organize the next revisions of their expectations, standards, curriculum, and assessment programs. The focal points are intended to frame discussions that will eventually inform the decisions of textbook publishers and assessment developers, as well. They answer the question, "What are the key mathematical ideas or topics on which the others build?" The ultimate goal would be for these suggestions, the Focal Points, to lead to the development of mathematics curriculum goals that are more cohesive from grade to grade and from school to school.

In fact, this process has begun in many states. NCTM has already made presentations in, or worked with, more than 20 states that are referring to *Curriculum Focal Points* as they develop State standards and assessments. Because mathematics is such an important foundation for all STEM fields, and because younger students learn mathematics almost exclusively in the classroom, the early mathematics education of all students is crucial to the future success of any STEM planning and policies.

Conclusion

Building on the momentum created by a series of landmark reports and the tireless work of leaders in education, business, industry, and government, the Congress in recent months has enacted important new policies that will potentially fuel this work. You and your colleagues on the House Science and Technology Committee accomplished much of this work. We thank you for all your efforts. Mathematics educators are particularly encouraged by new investments in teacher recruitment and retention programs, including the changes made to the Noyce Scholarship program, and a new Math Now initiative, which will help mathematics teachers teach students who are the hardest to teach. These innovations, which we hope will be funded, are sorely needed.

In closing, I cannot tell you how excited I am about the attention that mathematics and the STEM disciplines are receiving. The COMPETES bill, the NSB's plan, and conversations around changes to the Elementary and Secondary Education Act are the fruits of years of effort to bring about change, and I look forward to seeing where it takes mathematics educators and our nation's students.

I will be pleased to answer any questions. Thank you.

BIOGRAPHY FOR FRANCIS (SKIP) FENNELL

Dr. Fennell has experience as a classroom teacher, a principal, and a supervisor of instruction. He is currently Professor of Education at McDaniel College and President of the National Council of Teachers of Mathematics.

Widely published in articles and textbooks related to elementary and middle-grade mathematics education, Dr. Fennell has also authored chapters in yearbooks and resource books published by the National Council of Teachers of Mathematics. In addition, he has played key leadership roles with the National Council of Teachers of Mathematics, the Research Council for Diagnostic/Prescriptive Mathematics, the Mathematical Sciences Education Board, the National Science Foundation, the Maryland Mathematics Commission, and the Association for Mathematics Teacher Educators. On April 29, 2006 he began serving a two-year term as president of the National Council of Teachers of Mathematics.

Dr. Fennell has received numerous honors and awards, including Maryland's Outstanding Mathematics Educator (1990), McDaniel College's Professor of the Year (1997), and the CASE—Carnegie Foundation Professor of the Year (1997). He has also been the principal investigator on grants from the National Science Foundation, the U.S. Department of Education, the Maryland Higher Education Commission, and the ExxonMobil Foundation. He earned his Bachelor's degree from Lock Haven University of Pennsylvania and a Master's from Bloomsburg University of Pennsylvania before receiving a Ph.D. from Pennsylvania State University.

Chairman BAIRD. Thank you, Dr. Fennell.
Ms. Gayl.

STATEMENT OF MS. CHRISANNE L. GAYL, DIRECTOR OF FEDERAL PROGRAMS, NATIONAL SCHOOL BOARDS ASSOCIATION

Ms. GAYL. Good morning, Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee. Thank you for the opportunity to testify here today.

First, let me express our appreciation for the Committee's leadership in this area. Science, technology, engineering, and math or "STEM" education, is an important part of the education and skills that our students need to become productive workers, good citizens, and intelligent consumers in the 21st century.

In order to remain effective and relevant, our education system must be able to provide students with the content, knowledge, and skills that they will need to pursue STEM-related careers if they choose and also to adapt to the changes that society demands.

The National Science Board's Action Plan offers some useful suggestions on ways that the Federal Government can help to enrich teaching and learning in these fields. If I leave the Committee with just one overall impression today, I hope it is this: NSBA believes that this Action Plan is a step in the right direction. In particular, its focus on insuring an adequate supply of well-prepared and effective STEM teachers is essential to improving student learning.

However, we caution the Committee against some of the Board's recommendations that could ultimately erode State and local control over and public accountability for education. I would like to highlight a few of the key recommendations which are of particular interest to local school boards.

First, NSBA strongly supports the plan's focus on developing human capital to meet the need for an abundant supply of well-prepared STEM teachers. Local school systems encounter many barriers to recruiting and retaining high-quality teachers. The clear link between teacher quality and student achievement, coupled with estimates that two million new teachers will be needed in the

next decade, argues for a sustained commitment and partnership among all levels of government to build and maintain a strong teaching force.

NSBA supports an array of incentives, many of which are included in this report, to recruit and retain teachers, including performance-based pay, bonuses, alternative certification programs, and student loan forgiveness.

In addition, NSBA agrees that Congress should help strengthen teacher preparation programs within universities to insure appropriate alignment and accountability. Clearly we must insure that teachers have the content knowledge that their students will be expected to learn.

NSBA believes that the creation of a STEM education council could be helpful in coordinating the various STEM-related initiatives throughout the Federal Government, as well as in disseminating best practices and developing tools and resources for educators to use in the field.

However, as proposed, this council would have significantly greater powers and considerable influence over the direction of our nation's education policy, with little to no accountability or oversight. The approach of empowering a National council to develop academic consent, guidelines, and teacher certification requirements would divest State and local governments of their traditional responsibilities and authority over public education.

NSBA believes that the dissemination of content guidelines could be helpful in enriching math and science curriculum and helping communities to set clear expectations for their students.

However, we caution that it is a slippery slope from content guidelines to national standards. The Board's recommendation to align newly-developed content guidelines with the NAEP test and NCLB-related assessments would create a situation in which these guidelines really are not voluntary, since all states are mandated under federal law to participate in these assessments.

As a result, we believe that it is absolutely critical for this plan to emphasize flexibility for local and State education agencies, to choose curricula, and to design standards that best meet their needs.

Lastly, let me say that while this report addresses many important areas, it does not mention one significant need: the provision of hands-on, up-to-date, laboratory equipment and facilities which are critical in order to successfully implement a relevant STEM program. Failure to provide such resources will negate the efforts to implement high-quality standards and well-prepared teachers.

In conclusion, I would like to say that the Board's Action Plan is an important contribution to the national dialogue on STEM education. Greater federal leadership is needed in this area if we are to meet the challenges of the future. Congress can make an important contribution by providing school districts with the models, tools, incentives, and resources that they need to improve STEM education in their communities.

I thank the Committee for this opportunity to testify here today, and I look forward to your questions.

[The prepared statement of Ms. Gayl follows:]

PREPARED STATEMENT OF CHRISANNE L. GAYL

Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you for the opportunity to testify on the National Science Board's (NSB's) proposal to improve STEM education.

My name is Chrisanne Gayl. I am the Director, Federal Programs at the National School Boards Association. Our association represents the Nation's 95,000 local school board members.

Big Picture

First, let me express our appreciation for the Committee's leadership in this area. Science Technology Engineering and Math (STEM) education is an important part of the education and skills that students need to become productive adults and to compete successfully in the 21st century workforce.

As you know, the Bureau of Labor Statistics has estimated that the U.S. economy will add 1.5 million scientists, engineers, mathematicians, and technicians (of varying levels) between 2004 and 2014.¹ We must keep in mind, however that while jobs in the STEM fields are growing, they still comprise a small percentage of the 18.9 million jobs that are forecasted to be created in the U.S. economy.²

Nevertheless, as our world becomes more globally competitive, knowledge-based, and technologically driven, the need for students to develop STEM literacy has become more important. Evidence suggests that businesses of all types are encountering a need for employees with higher-level skills, regardless of the path that they choose after graduation.³

Furthermore, as individuals and as citizens, we are faced with decisions every day that demand high levels of understanding and judgment. A trip to the doctor, for example, often requires an understanding of statistics and analytical ability so we can compare the relative merits of particular treatments. As voters, we are called upon to make choices about issues regarding science such as global warming and stem-cell research.⁴

While the reality is that not all students—not even the majority of students—will go into STEM-specific jobs, the need for basic STEM literacy has become necessary in order to be productive workers, good citizens, and intelligent consumers. As responsible stewards of our children's future, our education system should be designed to provide students with the high-level skills they will need if they choose to pursue STEM-specific career paths, as well as adapt to the changes that our society demands in order to remain effective and relevant in the 21st century.

Throughout the country local school boards have been working to strengthen STEM education in a number of ways—through the integration of new technologies into the classroom, especially in subjects such as math and science where these tools are core to their real world application and simulation, offering more online learning opportunities, and increasing math and science course requirements.

Many school districts have also increased their offering of rigorous Advanced Placement (AP) courses. Research has shown that students who take AP courses are more competitive with their international peers on international assessments, and are more likely to pursue higher education degrees in science, technology, engineering and math.⁵

Congress can help to foster these educational successes by demonstrating greater leadership at the federal level. The National Science Board's Action Plan offers some useful suggestions of ways that the Federal Government can elevate the importance of STEM education and enable opportunities that will enrich teaching and learning in these fields. As an example, the Federal Government is in the unique position to assemble the profound knowledge base that exists within these disciplines and to disseminate information on effective tools, models, and practices that will strengthen STEM education. Additionally, Congress can provide valuable incentives to improve teacher quality and spur local investment in this area.

If I leave the Committee with just one overall impression today I hope it is this: We believe that this Action Plan is a step in the right direction for promoting high-quality STEM education in the U.S. Its emphasis on increasing public appreciation for and understanding of STEM education is consistent with the key work of local school boards to engage their communities and ensure support for these initiatives.

¹BLS, Occupational employment projections to 2014; *Monthly Labor Review*, November 2005.

²*Ibid.*

³ACT, Inc., *Ready for college or ready for work: Same or different?* 2006.

⁴Barth, Patte, "A Common Core Curriculum for the New Century," *Thinking K-16*, Vol. 7, Issue 1, Winter 2003.

⁵College Board, *Advanced Placement: Report to the Nation 2007*. http://www.collegeboard.com/prod_downloads/about/news_info/ap/2007/2007_ap-report-nation.pdf

In particular, the Plan's focus on ensuring an adequate supply of well-prepared and effective STEM teachers is absolutely essential to enhancing student learning in these fields.

However, we caution the Committee against some of the recommendations in this plan that could ultimately erode State and local control over education, which is the foundation of our education system and critical to public support for any initiative. The top-down approach of creating a national council to set academic content guidelines and teacher certification requirements is troublesome for school board members who value local flexibility and must deal with the day-to-day operational challenges of implementing these policies.

Furthermore, let me say that while the report addresses many important areas, it does not mention one significant need, the provision of up-to-date laboratory equipment and modern classrooms, which are necessary to successfully implement a relevant STEM program. Such facilities are essential for students to be able to experiment, create, and get a hands-on feeling for what the world of work is like in these fields. This scale of modernization will require a large infusion of capital and clear design guidelines if America's STEM classrooms are to be appropriately outfitted for the type of instruction that is envisioned in this report. Failure to provide the adequate resources to create appropriate classrooms for STEM teaching will negate the efforts to implement high-quality standards and provide well-prepared teachers.

In the remainder of my testimony, I would like to highlight a few of the key recommendations contained in the Action Plan, which are of particular interest to local school boards.

Qualified Teachers

NSBA strongly supports the focus on "developing human capital" in this plan to meet the need for an abundant supply of well-prepared teachers in STEM fields, a *sine qua non* in improving our education system.

As the report rightly notes, local school systems encounter many barriers to recruiting and retaining high-quality STEM teachers. The clear link between teacher quality and student achievement, coupled with estimates that two million new teachers will be needed in the next decade to address retirements and turnover, argues for a sustained commitment and partnership among all levels of government to build and maintain the teaching force needed to make a positive difference for America's students.

NSBA supports an array of incentives, many of which are mentioned in this report, to recruit and retain teachers in high-need STEM subjects and other areas, including performance-based pay, bonuses, alternative certification programs, and student loan forgiveness. NSBA believes that the best approach to increase teacher quality is to leverage the resources of the Federal Government to encourage the creation and expansion of a range of strategies, many of which states and school districts already are implementing.

In addition, NSBA agrees that Congress should help strengthen teacher preparation programs within universities to ensure appropriate alignment with academic standards and foster greater accountability among these programs. Clearly, we must ensure that teachers have the content knowledge that their students will be expected to know. We would suggest, however, that teacher preparation programs be aligned with existing State academic standards, which all states are required to have in place under No Child Left Behind, as opposed to "national content guidelines" that would be developed by an independent STEM education council.

Given that the majority of tomorrow's teachers are already in today's classrooms, we also believe that more attention should be given to developing and bringing-to-scale high-quality professional development programs for existing teachers. These programs can play an important role in updating teachers' knowledge and skills in their subject area and have been shown to have a positive impact on teacher retention.

National STEM Council

NSBA believes that the creation of a STEM education council could be helpful in coordinating various STEM programs and initiatives throughout the Federal Government, disseminating best practices, and developing tools and resources that educators can use in the field. However, as drafted, NSB's plan calls for the creation of an independent, non-Federal National Council that would have significant powers beyond these tasks and considerable influence over the direction of our nation's education policy.

For example, the council would: coordinate the development of national standards for STEM teacher certification, coordinate and assist with the development of na-

tional STEM content guidelines, and help states establish and strengthen P-16 councils.

NSBA believes that giving such responsibilities to an independent national council is in direct conflict with our locally and democratically-controlled public education system. Such an entity would divest State and local governments of their responsibilities and authority over public education, and institute a governance structure with little or no oversight or accountability that would be responsible for high-level decision-making.

Although the Board acknowledges in their plan that local and State governments “bear the ultimate responsibility in the Nation’s system of public education,” there seems to be a fundamental mismatch between what the plan says about the responsibilities of local government and what it is proposing in terms of the overall scope and mission of the council. It is worth noting that there are no permanent seats on the council to be filled by local school board members who are local governing officials. Yet, this entity would have significant responsibilities to coordinate among Federal, State, and local governments and impose its recommendations on such groups.

National Content Guidelines

As noted, one of the council’s responsibilities would be to “coordinate and assist with the development of national STEM content guidelines for pre-K-12.” NSBA believes that the dissemination of content guidelines may be helpful in enriching math and science curriculum and setting clear learning expectations for students, however, we caution that it is a slippery slope from content guidelines to national standards.

The Board’s recommendation to align these newly developed content guidelines with metrics, including the National Assessment of Education Progress (NAEP) tests and NCLB-related assessments, would create a situation in which these guidelines really aren’t voluntary since all states are required to participate in NAEP and to administer math and science assessments for particular grades under No Child Left Behind. As a result, we believe it is absolutely critical for this plan to emphasize that these guidelines should allow flexibility for local and State education agencies to choose curricula and design standards that best meet their needs.

As the Board notes in its plan, considerable work has already been done by a number of groups including the National Council of Teachers of Mathematics, the National Science Teachers Association, and the Association for the Advancement of Science through its Project 2061, to develop content guidelines or voluntary standards in various disciplines. Therefore, we need not reinvent the wheel. However, consideration should be given as to how such work fits within the larger context of ensuring that students are college and workforce-ready.

Conclusion

In conclusion, I would like to say that the National Science Board’s Action Plan is an important contribution to the national dialogue on STEM education. Greater federal leadership is needed in this area if we are to meet the challenges of the future. The National School Boards Association embraces the plan’s priority goals—to ensure greater coherence in the STEM education and to ensure that students are taught by well-qualified, highly-effective teachers. However, we remind the Committee that such policy goals must be workable and practical at the local level in order for them to succeed. Congress can help to make this happen by providing school districts with the models, tools, incentives, and resources they need to improve STEM education in their communities.

I thank the Committee for this opportunity to testify here today. Local school board members are encouraged by the attention that this committee has given to improving STEM education in the U.S. and the work that it has done to help ensure our children will be able to compete effectively in global economy. We look forward to continuing to working with you on this important issue.

BIOGRAPHY FOR CHRISANNE L. GAYL

Chrisanne Gayl joined NSBA in 2005 as Director, Federal Programs where she is responsible for developing and implementing legislative strategies to advance the federal policy interests of local school boards. Her work focuses on a variety of issue areas including education technology, workforce competitiveness, school health, and early childhood education. Before joining NSBA, Chrisanne was the Policy Director at the Workforce Alliance where she oversaw the organization’s direct and grassroots advocacy on federal legislation and national funding initiatives related to workforce education and training. She also served as the Federal Representative for

former California Governor Gray Davis, representing the Governor in Washington, DC on federal education policy, as well other social issues. Chrisanne holds a Master's degree in Public Policy from Georgetown University's Public Policy Institute and received her undergraduate degree from Colby College in Waterville, Maine.

STATEMENT OF DR. ROBERT J. SEMPER, EXECUTIVE ASSOCIATE DIRECTOR, THE EXPLORATORIUM, REPRESENTING THE ASSOCIATION OF SCIENCE AND TECHNOLOGY CENTERS

Dr. SEMPER. Good morning, Chairman Baird, Ranking Member Ehlers. It is my pleasure to be testifying on behalf of the Association of Science Technology Centers in response to the National Science Board's Action Plan. I am Executive Associate Director of the Exploratorium, a museum in San Francisco, representing 348 members of ASTC. ASTC members reach 58 million children and adults annually in bringing science and technology and mathematics and engineering to their communities.

It is fitting today that we are having this meeting 50 years after Sputnik. At that time an investment was made by the Federal Government to change STEM education. Decisions were made, and things got done. I am a personal product of that experience. I left fifth grade a happy-go-lucky kid, came back in sixth grade and found new equipment in the hall, a new textbook in front of me, and most importantly, a new teacher who had been trained by an NSF program to take me under her wing and to teach me science. All along after that through programs in college and graduate school I was supported by nationally-supported endeavors about science education, and it is a rare opportunity for me to actually thank the government, representatives of the government for that opportunity. Thank you very much for me but also for many other people in this country.

What is different 50 years later? Well, in many respects some of the things are the same, but one big thing is different. I, or my representative, would not have been here, because science centers did not exist 50 years ago. There were science museums doing good work, but the field of science centers developed actually as a result of the investments made 50 years ago in science education, again, through agencies like the National Science Foundation and other agencies like NASA.

And why that is important is I think we have a new landscape now to actually support new endeavors in STEM education. The rise of science centers, Pacific Science Center (Seattle) is an early one, and of course, OMSI (Portland) and The Exploratorium and others are key elements of the development of the out-of-school movement in science education, which includes science centers but also media, the Internet, and other kinds of after-school programs.

These programs offer a supporting structure for science education that did not exist before, and it is one of the reasons why the notion of having in the NSB report a coherent structure and a place at the table for these kinds of agencies is so critical.

This is really important if we take our view of science education from the kids' eye view and not the institutional eye view. If we think of our kids, they basically are in school, but they also go to museums, they go to museums, they watch media, they go home and talk with their parents about science, they have interactions

with peers, they go to after-school programs. This is really important if you realize only 1,000 hours of science instruction is provided K–12 to our students. That number, 1,000 hours, is not going to change. That is one half of an adult's working year. We have to look at the entire system if we are going to actually look at the questions of improving STEM education.

Therefore, ASTC and the science center community supports both of the priority recommendations included in the plan presented by the National Science Board; the coherence in the Nation's STEM education system and recommendations assuring an adequate supply of well-prepared and highly-effective teachers. And I want to point out that science centers are actually able to play a role in meeting both of these recommendations.

First the coherence issue. It is critical that we engage all the stakeholders in this process, but, of course, all of these stakeholders have different funding strategies. The main school systems are funded by states and local funding with federal funding coming through the states down to the local schools and school districts. The science centers community, my community is funded by local contributions, by philanthropic contributions, by people paying tickets, money at the door, and also by national programs that we can compete for. These two areas do not come in contact very well, and we need to have a place of engagement so we can understand who can do what best and how these programs could come together.

Science centers, for example, are effective in providing research on learning and educational practices. For example, the Center for Informal Learning at School at my organization is doing research on how museums can participate in the STEM education process broadly.

They also are involved in developing human capital in terms of teacher development. In fact, science centers were involved in producing about 25 percent of the elementary teacher in-service training a number of years ago, and we have a number of teachers, for example, at my institution from around the Bay Area coming to workshops and becoming a part of a teacher home at the Exploratorium.

And most importantly science centers also can provide support for the public appreciation of science and of science education. There are opportunities for a forum for discussion in communities about what science education should be like.

We are also supportive of the inclusion of science centers and other parties in the State P–16 councils. In California our council includes representatives from districts, from universities, from community colleges, from workforce, but, for example, it does not include representatives from libraries, from museums, from media, all a part of the solution to the problem. If we can get coordinated and integrated, I think we can maximize the investment that is being made in each of these sectors in a strong way.

Looking at the teacher issue, we completely agree that well-qualified teachers is critical if we are going to reach under-served students, and there is a lot of research that shows under-served students get under-qualified instruction. That has to change. One way to address this would be to actually develop new forms of professional development for teachers to go beyond the traditional uni-

versity model, school district model, to think of alternatives that might include institutions like ours in the science center world, or in other worlds that could help make a new method of development of teacher education similar to what was done in medical school 100 years ago in terms of professional development.

And finally I would like to address the question of roadmaps. It is clear that we need a roadmap. We need a national roadmap for science education in this country. NSF needs an internal roadmap because we are really faced with an engineering problem. How do we engineer improvement in science and science education at large? And a roadmap that is clear and concise so people can find their role would be very powerful in that regard.

Thank you for your interest, and I look forward to answering your questions.

[The prepared statement of Dr. Semper follows:]

PREPARED STATEMENT OF ROBERT J. SEMPER

Chairman Baird, Vice Chairman McNerney, Ranking Member Ehlers, and distinguished Members of the Subcommittee, thank you for the opportunity to discuss the findings and recommendations contained in the National Science Board's Action Plan for STEM Education. My name is Rob Semper and I am Executive Associate Director of the Exploratorium, a Museum of Science, Art and Human Perception in San Francisco. The Exploratorium is one of over 348 science centers and museums in the United States that are members of the Association of Science Technology Centers (ASTC). These institutions offer critical science, technology, engineering and mathematics education in informal settings to over 58 million children and adults every year including specific programs for students and teachers. I have been asked to represent the views of the field of these informal science education institutions to the NSB's Action Plan.

It is fitting that this hearing is occurring 50 years to the week that this nation was shocked by the launch of Sputnik into addressing the issue of STEM education in a comprehensive way. As a result of that experience an investment was made that made a difference and that difference has been demonstrated by the significant advancement in STEM leadership that this country has enjoyed since that time. Building on the existing science education reform work already underway, the national resolve to invest in STEM education resulted in new curriculum being developed and disseminated, enhanced professional development of teachers being provided, and the launching of significant efforts to promote public engagement in science. New science education research and development organizations were created to support this work. A STEM education improvement infrastructure was created. We called on our universities, our scientists and our schools to work together to improve the situation and they did. In short the country was galvanized to do something about the problem.

I am a product of the tremendous effort and investment that was made at that time to improve science education in this country. Upon returning to school to start my sixth grade class, I was met with the scene of crates of lab equipment being unpacked in the hall, newly minted science textbooks and, most importantly, a sixth grade teacher who had been trained in an NSF sponsored summer science teacher institute who took me under her wing as a budding scientist. Later in high school I was taught physics by an Ex Navy nuclear submarine engineer who entered teaching through a Department of Defense career transfer program and in college I attended a summer NASA undergraduate research program where I learned what it meant to be a scientist instead of a science student. In graduate school I participated as an instructor in an NSF sponsored program to introduce a new self paced science curriculum at the undergraduate level and I spend a summer at Los Alamos National Laboratory in their graduate student program doing exciting physics research.

I am mentioning all of this not to impress you with my resume but to point out that each and every one of these experiences was supported by the Federal Government and would just not have happened if there had not been strong federal support for STEM education. And in particular I want to point out the vital and unique role that NSF played in leading and supporting this effort over the years. It was their support of quality programs through their rigorous peer review process of proposals

from universities, schools, museums and education research labs that provided the research, development and implementation of much of this work.

Today we are eerily confronting the same concerns as our previous generation did in 1957. We perceive a threat to our future, we realize that we need to make an investment in STEM education to mitigate this threat, and we are asking the Federal Government to help. In many respects we might think that we are in the same place as 1957 and indeed many of the proposed solutions today might be similar to those proposed 50 years ago. But at least in one major respect things are quite different. The field that I represent here today simply did not exist.

One of the legacies of the post Sputnik investment in STEM education was the creation and widespread dissemination of a new kind of educational institution, the science center. These new places were born out of the confluence of the investigation-focused science education reform movement of the late 1950s and the learner-centered educational movement of the mid to late 60s. They borrowed interactive exhibits from the science-and-industry museums, the informational displays of the Worlds Fair science exhibitions, and the science demonstrations common to schools and universities to create new institutions that contained collections of ideas rather than things. These institutions rode the wave of the de-authoritization of formal education—the dramatic shift toward the empowerment of students and individuals to be in control of their own learning—that swept through the country and the world at that time. The oft-repeated statement by Frank Oppenheimer, the Exploratorium's founder, that "No one flunks a museum" became emblematic of a public education movement that has spawned hundreds of science centers and has advanced exhibition development in science museums, natural history museums, zoos, aquariums, and planetariums worldwide.

These science centers now form a powerful new community-based resource that can play a significant role in advancing STEM education nationwide. They serve a significant part of the U.S. population. They offer experiences that are rich in science, and as importantly, engaging to visitors of all ages. They are repositories of science-trained staff that help students gain a deeper understanding of science, nature and the world around us. They support teacher professional development activities for grades K–12 and they develop curriculum. They partner with schools, universities, industry and community groups to provide STEM education for all citizens. And they provide a focus of commitment to science in their community that is both respected and accessible.

For example every year, my organization, the Exploratorium, welcomes over 500,000 children and adults to a lively exhibit space in San Francisco that is filled with 500 exhibits on topics as diverse as light and color, genetics and the brain. We provide the public access to the latest images from the Mars rover, an opportunity to talk to scientists working in Antarctica and the science of skateboard wheels. Our audience includes 100,000 field trip students who come from the diverse school population of the Bay Area, many of whom are under-served in STEM. Through the use of the Internet we reach an additional 18 million kids and adults nationwide with online exhibits and teaching tools developed at our institution. Using the exhibits, our professional development staff works intensively with over 500 teachers a year to develop their science teaching skills and actively support an alumni community of over 2,500 Bay Area teachers who use the museum as their science home away from home.

The development over the years of this robust group of science centers and museums, along with the expansion of other out of school resources such as after-school programs and clubs and science related media, is an important part of the solution to advancing STEM education. To successfully make the improvement in STEM education that we all desire, we will need to make use of all of these opportunities due to one sobering fact. The average amount of time that a student will spend in school on science throughout their K–12 career is only 1,000 hours. That is one half of an adult working year. Given the fact that there is no realistic prospect of increasing this time due to the competing demands on school time, we simply must take advantage of the out of school time if we are going to make headway on STEM education.

Response to Specific Questions

It is with this background as a member of the science center and museum community represented by ASTC that I am responding to the recommendations of the NSB report and addressing the questions posed to me by Chairman Baird.

Does the NSB Action Plan address what you see as the key issues for improving STEM education? Are there specific actions or policies that you believe are important to improvement of STEM education that are not included? What are the principal barriers to achieving the recommended changes to STEM education system?

We support both of the Board's priority recommendations: (1) the need to ensure coherence in the Nation's STEM education system; and (2) the need to ensure that students are taught by well-qualified and highly effective teachers. Our field is pleased that the report recognizes the importance of informal science education institutions. They are the catalyst for sparking interest in STEM issues at all ages. Clearly this interest has overwhelmingly positive future implications for workforce development, teacher preparation, science interest and literacy and quality of life. However, we are concerned that our field is not always considered as part of the solution when the talk turns to STEM education.

Priority Recommendation A: Ensure Coherence in the Nation's STEM Education System

This is a key issue for improving STEM education because it addresses the key barrier to achieving the recommended changes to STEM education—recognizing the fact that STEM education is not just the province of the schools and therefore bringing all the stakeholders to the same table. There are many different things to be gained by this coherence but let me give you an example from my own field.

While our children (and our teachers) experience science in and out of school, the systems of formal schooling and out of school learning opportunities currently do not have a place to talk with each other to develop a coordinated approach. They are funded by different processes at the federal, State and local level, they have different (albeit complementary) goals and they have different strengths and weaknesses. By stepping back and looking at the STEM learning environment as a whole with the permanent representation of the informal education community on both the proposed National Council and the State P-16 Councils, we would have the opportunity to develop the needed coherency and synergy between these two worlds.

A.1 Actions for Coordination of Key Stakeholders

This action item is an exceedingly important part of this plan from our perspective. Traditionally as private, non-profit organizations, science centers get national support for their own educational activities from peer reviewed grant opportunities primarily at the NSF, NASA, NIH and the Department of Education. They also provide a venue for public engagement for the science outreach activities of NSF, NASA, NIH, NOAA, the Department of Energy and the associated universities and labs receiving these research dollars. They receive most of their funding to support their educational work from local philanthropic giving, local government funding and institutionally earned income. As independent entities they develop their own agenda. Formal education on the other hand is supported primarily through federal and State funds and local taxes that is given to the local education agencies and the school agenda is driven by various policy initiatives supported by the funders and determined by local school boards and the state. Coordination of key stakeholders at the national and State level in a system like this is required if one is to develop a synergistic approach.

We support the leadership role outlined for NSF in the report and the development of a coherent internal framework for its own work in education. Our new century needs leadership in the innovation of STEM education for the 21st century with a focus on new ideas for instruction, staff development and the use of new technology. Science centers are active players in all three domains of identified NSF leadership—research on learning and educational practice and the development of instructional materials; development of human capital in STEM fields, including STEM teachers; and the improvement of public appreciation for and understanding of STEM. NSF is a key supporter of our field and it is important that informal science education institutions maintain an eligibility to apply for funds in each of the areas in NSF to continue this work in the future.

The report's support for the continued development and funding of programs that increase public appreciation for and understanding of STEM is most appreciated by ASTC and our members, as is the specific mention of museums and informal science education learning environments in this context. While ASTC agrees that collaboration between all NSF directorates and offices should be encouraged in this effort, we strongly believe that any such collaboration should not come at the expense of the NSF EHR's Informal Science Education program, be it its scope or mission. This vital, peer-reviewed program, designed to increased interest, engagement, and understanding of STEM by individuals of all ages and backgrounds, must remain robust.

A.2 Actions for Horizontal Coordination and Coherence and A.3 Actions for Vertical Alignment and Coherence

Beyond the national coordination of key stakeholders, science centers are key participants in local and statewide STEM educational efforts. We appreciate the report's support for including informal science education institutions in the newly-created and existing statewide P-16 councils. It is important that these councils also develop a broader view of the STEM education landscape if they are to create coherency in a students' educational life. As institutions we interact with students all along the educational continuum from field trips through summer classes to an employer of STEM educated staff. In some cases our institutions provide facilities and hands on engagement that schools just cannot provide. Active participation in the statewide dialogue about STEM education will insure a more coordinated approach to our offerings and also our ability to provide the many parents who visit our places information about high quality STEM education.

Priority Recommendation B: Ensure That Students are Taught by Well-Qualified and Highly Effective STEM Teachers

The focus on the STEM teacher workforce as a high priority is absolutely important. But in addition to the recommendations presented in the report I would propose to add one more based on my past experience in the informal education field and teacher education. We need a program to develop innovative new models for teacher professional development, ones that address the issues as dramatically as the invention of the teaching hospitals and medical schools did for medical professional education at the turn of the last century.

For example, science centers have historically participated in teacher professional development activities primarily through peer reviewed proposals to the NSF and the U.S. Department of Education. They have made use of their unique environments and scientific staff to provide in-depth and ongoing professional development to teachers in their region and in some cases they have become a professional home for science teachers in their community. The Exploratorium works with teachers from 140 school districts that exist in the Bay Area providing a consolidated approach to intensive teacher professional development for the region. Other science centers such as the Pacific Science Center in Seattle operate statewide initiatives.

But because teacher professional development is currently only considered the province of the LEAs and IHEs in current federal and State legislation, there is little opportunity for science centers to play the lead role in creating new community based teacher professional development models. Opening up eligibility for funding as the prime award winner to non-profits with the experience and capability to do good work is critical if we are to develop alternative approaches. A program to actively create new models of professional development will lead to the dramatic change in STEM education that we are all seeking.

Is the proposed national STEM education council needed in order to implement the NSB's recommendations; can it be made to work as envisioned; and can it become self-sustaining? Do you support establishing this council? Do you have recommendations for changing the proposed structure or function of this council? Furthermore, what role do you envision for the council in defining the recommended "national content guidelines"?

It is clear that a coordinating function at the national level with membership of all of the stakeholders is critically needed if we are to maximize our investment of resource. Currently there does not exist a venue for this discussion that is both specific to STEM and inclusive of all of the potential players. This is in addition to the need for coordination of Federal Government's response to the issue. Therefore ASTC is intrigued by the idea of a National Council for STEM Education, and appreciates the Board's recommendation that informal science educator should be represented in its membership. We would recommend that an informal science educator should hold a permanent seat rather than a rotated one, however, especially given the role that informal science institutions play in student and teacher education.

What is the appropriate federal role in carrying out the recommendations of the NSB Action Plan?

While many of the reports recommendations concern initiatives that are clearly at the State and local level, the fact that much of the current funding for the improvement of STEM education comes from the federal coffers means that it is an important federal role to establish mechanisms to provide coordination amongst the involved parties and to develop a STEM education improvement roadmap for the country.

It is also the federal role to provide the investment in innovation for STEM education and the national support for STEM education improvement. To this end we would strongly endorse the reports recommendation that the National Science Foundation (NSF) exercise a significant leadership role in research and development, STEM workforce development and public STEM engagement and the Board's recommendation that NSF develop an internal agency roadmap toward this end.

In closing I would like to thank you for offering me the chance to testify on this very important issue. I look forward to answering any questions that you may have.

BIOGRAPHY FOR ROBERT J. SEMPER

Rob Semper is Executive Associate Director and Director of Program for the Exploratorium in San Francisco and is responsible for leading the institution's work in developing programs of learning and teaching for the public and educators using exhibits, workshops, media and Internet resources. Dr. Semper is the principle investigator on numerous science education, media and research projects including leading the National Science Foundation sponsored Center for Informal Learning and Schools, a research collaboration between the Exploratorium, U.C. Santa Cruz and King's College, London which studies the relationship between museums and formal education. He is also Co-PI on the NSF funded Nanoscale Informal Science Education Network, a national network of science centers designed to foster engagement of the public with the nanotechnology field. He leads numerous research and development projects in new media including wireless networks, hand-held computing and advanced Internet applications.

Over the past fifteen years Dr. Semper has guided the development of the award winning Exploratorium Website that has explored the role of museums in the online world including the development of on-line field trips to locations of scientific research. He has been executive producer for a number of NSF and NASA supported Webcast/Website projects including Origins that provides on-line field trips to science observatories worldwide, four Solar Eclipse Webcasts and the Ancient Observatories project that originated live from Chaco Canyon and Chitzen Itza. Before this, Dr. Semper was a Schumann fellow at the Harvard Graduate School of Education and director of the creative collaboration between Apple Computer and Lucasfilm Ltd. formed to develop interactive multimedia education projects. Previous to this since joining the Exploratorium in 1977, he has lead numerous exhibit development, teacher enhancement and media development projects focused on science education for the public, teachers and students. Dr. Semper was elected to be a 2006 American Association for the Advancement of Science (AAAS) Fellow and was the recipient of the 2006 NSTA's Faraday Award for Science Communication, the 1994 NSTA's Informal Educator of the Year award and the 2000 Association of Science Technology Center's Award for Innovation for the Exploratorium's leadership in developing on-line media. He has served on numerous advisory boards including the George Lucas Educational Foundation National Advisory Board and the AAAS Committee on the Public Understanding of Science. Dr. Semper has a Ph.D. in physics from Johns Hopkins University and was a post-doctoral student at Lawrence Berkeley Laboratory and a faculty member at St. Olaf College in Northfield, MN before joining the Exploratorium in 1977.

Chairman BAIRD. Thank you, Dr. Semper.

STATEMENT OF MS. SUSAN L. TRAIMAN, DIRECTOR, EDUCATION AND WORKFORCE POLICY, BUSINESS ROUNDTABLE

Ms. TRAIMAN. Mr. Chairman, Ranking Member Ehlers, Members of the Subcommittee, good morning. I am Susan Traiman, Director of Education and Workforce Policy at Business Roundtable, and like Dr. Semper a beneficiary of the post-Sputnik investment, although I didn't go into STEM, I did have a loan to go to college from the *National Defense Education Act*.

Thank you for inviting me to testify before you today on STEM education and the recent report from the National Science Board. I want to thank Dr. Beering and the members of the National Science Board for their important work on behalf of U.S. STEM education.

Business Roundtable, as many of you know, is an association of chief executives of leading corporations with a combined workforce of more than 10 million employees and \$4.5 trillion in annual revenues.

Our CEOs are united in their concern about STEM education in the U.S. They understand that STEM education is a critical underpinning of both national economic competitiveness and individual success in the modern workforce.

From Norm Augustine, who was our taskforce on education chairman 11 years ago, to our current education taskforce chairman, Art Ryan, the CEO of Prudential Financial, CEOs believe that expanding the talent pool of Americans with a firm grounding in STEM disciplines is a critical element of the innovation agenda the United States must pursue in order to remain competitive in the 21st century.

The National Science Board identifies two central challenges to STEM education in the U.S.; insuring coherence in STEM learning and insuring an adequate supply of well-prepared, highly-effective STEM teachers. Both challenges have been the subject of countless reports and federal and State initiatives of the past 20 years, and both reflect the overall problems and dysfunctions with the K-16 education system in the United States or non-system in the U.S., as well as issues that are unique to STEM.

Business Roundtable is in complete agreement with the National Science Board that the critical bottleneck in U.S. STEM education is the inadequate supply of well-qualified, highly-prepared teachers. That is why our member CEOs were so enthusiastic about the STEM education legislation moved by this committee and enacted as part of the *America COMPETES Act*. And as you well know, the potential impact of this critical legislation depends on what happens to its appropriations this year and in future years.

One of the best features of the *America COMPETES Act* is its emphasis on expanding programs that have the demonstrated record of success such as the Robert Noyce Scholarship Program and the Math and Science Partnership Program. Time and again, in fact, since the post-Sputnik years we learn over and over that well-intentioned STEM initiatives fail because of inadequate attention to teacher preparation and professional development.

From *No Child Left Behind* to the *Higher Ed Act* to *America COMPETES Act*, we need to build on lessons learned about what will produce results.

And we also need to be open to new models that address issues such as the need to increase compensation for STEM teachers despite longstanding resistance to recognizing performance or market demands in determining teacher pay.

Nearly every one of the National Science Board's recommended actions for increasing the number of well-qualified STEM teachers and improving the quality of STEM teacher preparation have been endorsed by Business Roundtable and the national business organizations that are partners in Tapping America's Potential coalition or TAP, a business coalition committed to improving STEM education in the United States. So we agree that the Board has it right with respect to teachers.

When it comes to the Board's recommendations for improving integration and coordination of STEM education programs, I would urge caution. I should emphasize that the views I am about to share with you are my own, since Business Roundtable has not come to an official position on this particular aspect of the Board's report.

For CEOs of leading global companies, the idea of 50 different State-specific standards for what students need to know and be able to do in STEM is absurd. U.S. performance on international assessments makes it clear that the appropriate comparison is not between states but between states and our international competitors. In this context State-specific standards defy logic, but history and politics often create conditions where logic defying outcomes prevail.

The National Science Board also recommends creating new government structures to achieve vertical and horizontal integration in STEM education. In an ideal world the Board's recommendations might make sense, but I fear they don't account for the history and the politics that got us where we are today.

In my written testimony I go into some detail about the political and historical pressures that have caused education standards wars over the past 20 or so years where very reasonable and modest proposals to establish voluntary standards didn't result where we want them to be. And that is why we are not supporting the creation or development of voluntary national standards and assessments as part of the reauthorization of No Child Left Behind.

In the follow up to this I can address some of your questions about why the recommendations for this new council may create more problems than it attempts to solve.

Thank you, and I look forward to your questions.
[The prepared statement of Ms. Traiman follows:]

PREPARED STATEMENT OF SUSAN L. TRAIMAN

Mr. Chairman, Ranking Member Ehlers, Members of the Subcommittee. Good morning. I am Susan Traiman, Director of Education and Workforce Policy at Business Roundtable.

Thank you for inviting me to testify before you today on science, technology, engineering and mathematics (STEM) education and the recent report issued by the National Science Board, *A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System*.

Business Roundtable is an association of chief executive officers of leading corporations with a combined workforce of more than 10 million employees and \$4.5 trillion in annual revenues. The chief executives are committed to advocating public policies that foster vigorous economic growth; a dynamic global economy; and a well-trained and productive workforce essential for future competitiveness.

America's business executives are united in their concern about STEM education in the United States. They understand that STEM education is the critical underpinning of both national economic competitiveness and individual success in the modern workplace. In 2005, Business Roundtable, together with fourteen other national business associations, created the Tapping America's Potential campaign, or TAP, with the goal of doubling the number of American science, technology, engineering and mathematics graduates with Bachelor's degrees by 2015. Business Roundtable members believe that expanding the talent pool of Americans with a firm grounding in STEM disciplines is a critical element—perhaps the critical element—of the innovation agenda that the United States must pursue in order to remain competitive in the 21st Century. Several of our members served on the committee that issued the National Academies report, *Rising above the Gathering Storm*, and Norm Augustine, the committee's Chairman, is a former Chairman of Business Roundtable's Education Task Force.

Business Roundtable endorsed, and worked actively for the passage of, the vital STEM education legislation that originated with this committee and which was enacted as part of the *America COMPETES Act*. The potential impact of this legislation depends on what happens to its appropriations this year and in future years.

In your invitation, you have asked me to comment on the National Science Board report. My remarks reflect the sentiments I am hearing from business leaders, as well as my experience working on these issues at the federal, State and local levels.

The National Science Board identifies two central challenges to STEM education in the United States: ensuring coherence in STEM learning and ensuring an adequate supply of well-prepared, highly effective STEM teachers. Both challenges have been the subject of countless reports and federal and State initiatives over the past twenty years. And both reflect the overall problems and dysfunctions with K–16 education in the United States as well as issues that are unique to STEM.

On Coherence and the recommendation to “Develop Nation STEM Content Guidelines”: For CEOs of leading global companies, the idea of 50 different State-specific standards and assessments for what students need to know and be able to do in STEM is absurd. U.S. performance on international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) makes it clear that the appropriate comparison for education performance is not between states, but between states and our international competitors. In this context, State-specific standards defy logic. But history and politics often create conditions where logic-defying outcomes prevail.

The National Science Board recommends creating new governance structures to achieve vertical and horizontal integration in STEM education. In an ideal world, the Board’s recommendations might make sense, but I fear that they do not account for the history and the politics that got us where we are today.

We have been down this road before and our experience suggests that caution may be in order. When Business Roundtable first got involved in standards-based education reform in the early 1990s, CEOs focused at the State level, which is where the primary responsibility for education standards resides. CEOs identified nine essential components of a successful education system and either joined or created State business coalitions to advocate for systemic education policy reform. This marked two major shifts for business—first, a move away from the “adopt a school” approach toward changing the State education policies that affect all schools and students and second, a move away from single silver bullet solutions toward systemic reform with aligned policies based on high academic standards for all students. At the time, to the extent that states had standards, they tended to be minimum competency. While advocating for change at the State level during the 1990s, Business Roundtable also endorsed proposals by both the Bush (I) and Clinton Administrations for voluntary national standards and tests. However, both the Bush and Clinton initiatives were resoundingly rejected.

The actual development of national standards started with math through a non-governmental initiative by the National Council of Teachers of Mathematics (NCTM) in 1989. Textbook companies quickly aligned their materials with the NCTM math standards, and the Federal Government funded other professional groups to develop national standards in their content areas. The quality of the standards produced by these national subject-matter groups varied widely. To reach consensus, authors added rather than subtracted standards and many were so voluminous that there would be no time left to teach other subjects. Meanwhile, states began to develop their own standards in core academic subjects, frequently adapting their work from the national documents. Similar to the national standards, the quality of States’ standards was, and continues to be, inconsistent.

By the mid-1990s, criticism from across the political spectrum about the quality and content of the standards—both national and State—threatened to end standards-based reform. To rescue the movement, governors and business leaders created Achieve in 1996 to help states benchmark and improve their standards, as well as align them with assessments and accountability. It was clear at that juncture that State level standards were the only politically viable approach, but business leaders hoped that comparisons of quality and identification of State and international exemplars by Achieve would help push states in a common direction.

Shortly before President George W. Bush was inaugurated in January 2001, he invited a group of Business Roundtable CEOs to a meeting where he told them that his first initiative would be federal education legislation and asked for their support. Business Roundtable helped lead the business community’s involvement in shaping and passing the *No Child Left Behind Act* (NCLB). One of the most controversial parts of the bill required all states to participate in the National Assessment of Educational Progress (NAEP). Business leaders understood that NAEP was necessary to provide a common metric that enabled comparisons between states because

NCLB accountability was based on states' own standards and tests. During the debate, Members of Congress were assured that NCLB would not lead to national standards and tests. Republicans, in particular, sought that clarification because they viewed national tests as a Clinton idea, forgetting that the first proposals for national testing and federal funding for the development of national standards in core academic subjects happened under the leadership of President George Herbert Walker Bush and then Secretary of Education Lamar Alexander. So NCLB as originally passed reinforced the role of each state to develop its own standards and assessments, as well as its own definition of proficiency and cut score for proficiency on its own test.

Just last week, a new analysis of where 26 states set the proficiency bar by Northwest Evaluation Associates and the Thomas B. Fordham Foundation revealed wide variations between passing scores in reading and math across the states. That math should be easier in one state than another is bizarre in a global economy.

Although it continues to be absurd in our international economy for states to have different standards in reading and mathematics, the business community is not currently promoting the development of voluntary national standards and assessments as part of the reauthorization of NCLB. To put it simply, we do not believe that federal involvement at this juncture would be helpful in moving a process that is gaining ground at the State level. Working with Achieve, nine states are collaborating on the development of a common end-of-course test for Algebra 2. Thirty states are working to align their requirements for high school graduation with the expectations of higher education and the workplace. For now, the best approach is to include incentives in the reauthorization of No Child Left Behind for states to raise and align their standards and assessments so that students graduate from high school ready for post-secondary education and the 21st century workforce, and then backward map those standards for each grade so that they are vertically aligned.

It is important for the U.S. to get to "national content guidelines" or "voluntary national standards" or whatever euphemism is "politically correct" for national standards. However, I believe that a federally-initiated effort under the purview of a National Council for STEM Education is likely to be counterproductive, at this point, in light of the history and politics that continue to surround this issue. It also is likely to produce guidance that has not realistically addressed the tradeoffs in establishing priorities for what students need to know and be able to do that will be essential for schools that also need time to teach history, English, foreign languages, the arts and other important content.

You have specifically asked for my view on the recommendation to establish a STEM education council. Business Roundtable does not have a position on this matter but, for myself, I am skeptical. Someone once said that collaboration is an unnatural act between non-consenting adults. People also tend to be willing to collaborate if it is with the other person's money. I am all for more coordination and collaboration between federal agencies with responsibility for STEM education but it is difficult to enforce meaningful collaboration without budget authority. I am not convinced that a new layer of coordination with no real authority will improve the situation. Also, many of the worthwhile recommended activities could be accomplished within the existing mission of agencies.

On STEM teachers: Business Roundtable couldn't agree more that the critical bottleneck in U.S. STEM education is the inadequate supply of well-qualified and highly prepared STEM teachers. That is why our member CEOs were so enthusiastic about the STEM education legislation moved by this committee and enacted as part of the *America COMPETES Act*—because it focused on producing more well-qualified STEM teachers. One of the best features of the legislation is its emphasis on expanding programs that have a demonstrated record of success, such as the Robert Noyce Scholarship program, the Mathematics and Science Partnership program, and the Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP), also known as the "tech talent" program at NSF. Time and again—in fact since the post-Sputnik years—we learn over and over that well-intentioned STEM initiatives fail because of inadequate attention to high-quality teacher preparation and professional development. From *No Child Left Behind* to the *Higher Education Act* to the *America COMPETES Act*, we need to build on lessons learned about what will produce results.

Nearly every one of the National Science Board's recommended actions for increasing the number of well-qualified STEM teachers and improving the quality of STEM teacher preparation have been endorsed by Business Roundtable and the national business organizations that are partners in the TAP coalition. The July 2005 TAP report makes specific recommendations that are very similar to those of the National Science Board, including:

- Promoting market- and performance-based compensation and incentive packages to attract and retain effective STEM teachers;
- Creating professional development and technical assistance to fill gaps in teachers' content knowledge; and
- Establishing incentives for colleges and universities to strengthen preparation programs for prospective STEM teachers.

In conclusion, Business Roundtable is on the same page as the National Science Board in terms of the depth and urgency of the problem with regard to STEM education in the United States. Like the Board, Business Roundtable believes the highest priority for STEM education policy should be recruiting, training and retaining many more well-qualified STEM teachers.

I would like to take this opportunity to thank Dr. Steven Beering and the members of the National Science Board for their important efforts on behalf of U.S. STEM education. Business Roundtable looks forward to working with the Board to strengthen U.S. STEM education and support NSF's STEM education programs.

Mr. Chairman, Ranking Member Ehlers and Members of the Subcommittee, thank you for the opportunity to testify today.

BIOGRAPHY FOR SUSAN L. TRAIMAN

Susan Traiman is Director of Public Policy at Business Roundtable where she oversees the Roundtable's work with chief executive officers of leading corporations interested in improving education performance and workforce competitiveness in the United States. Recently cited as "the most influential chief executive lobbying group in the U.S." by the *Financial Times*, Business Roundtable members are at the forefront of public policy, advocating for a vigorous, dynamic global economy. Currently the Roundtable, working with fourteen other national business organizations, is leading the "Tapping America's Potential" campaign to double the number of science, technology, engineering and mathematics graduates with Bachelor's degrees by 2015.

Prior to joining Business Roundtable, Ms. Traiman was Education Policies Studies Director at the National Governors Association where she worked with governors on the first National Education Summit and the development of National Education Goals. She also was a senior associate with the U.S. Department of Education's Office of Educational Research and Improvement where she served on the staff of the National Commission on Excellence in Education and contributed to its landmark 1983 report, *A Nation at Risk*. Before coming to Washington, D.C., she worked at the State level for a regional technical assistance center and at the local level as a seventh grade social studies teacher.

Ms. Traiman has a B.A. in American Civilization and M.S. in Education from the University of Pennsylvania.

DISCUSSION

Chairman BAIRD. I thank the witnesses for a very diverse set of perspectives on this issue, and I commend the staff for having put together a group of folks with different perspectives from different important bodies.

I will recognize myself for five minutes, and then we will proceed with questions from other Members of the panel.

One of the issues that puzzles me is that we, when we look at our nation's competitiveness with other countries, national testing, virtually all the countries that we are trailing behind have national standards and national curricula. I am a ski instructor and also learned to scuba dive recently, and I will tell you, my understanding of both those areas of recreational pursuits is that wherever one goes in the country, if one is going to be a PADI-certified diver, all the divers all across the country got similar training. And so too with ski instructing. Now, there will be individual variations, and you get sometimes good teachers, sometimes bad, but if you go through a PADI diving course, wherever you are in the country,

those instructors had a similar curriculum, you have a similar book all across the country.

It puzzles me that we can't seem to get around that. To be perfectly blunt I think local control is a shibboleth but not a policy. And so I don't, I want to raise that question, and the vision I would ask is we talk about, and all of you said in a degree that teacher training is the core, and yet what are we training the teachers for? Are we training a teacher in Colorado to not teach in Iowa? Are we training a teacher in Iowa to not teach in Wisconsin?

And I want to throw that out there. I am an advocate of at least exploring very seriously this notion of some form of national curriculum at least on a voluntary basis in science and math education, and I am interested, I will just throw that out there, in the pros and cons of that. Why can't we do it, why shouldn't we do it?

Dr. Fennell?

Dr. FENNELL. Well, I would like to speak in support of your frustration, not that you are frustrated, but I see the same frustrations. We have at the moment 49 of our 50 states that have curriculums out there, in particular Pre-K through eight mathematics, and they range from somewhere in the 30 objectives all the way to over 100, depending upon how you count. And yet if you get underneath that, I don't know anybody in this room or anywhere else who wouldn't want elementary-age children to know how to add and subtract well and similarly with multiplication, division, and later on be pretty proficient in their work with fractions and so forth, all leading to algebra.

Our work with the Focal Points, our work with now close to half of the states in this country, my work with the National Math Panel where we are pretty close to suggesting benchmarks for all students as they move into algebra is pretty important. If we want to be competitive with those other cultures that you alluded to, if we want to make sure our kids are ready for higher-level mathematics, if we would like more students ready for a math-intending, science-intending career, that has to happen.

Ms. GAYL. I would like to just address that on behalf of local school boards. We would say that as a Nation of 300 million plus individuals and 50 million school children with a vast array of resources and differences of opinion, that we need to allow room for experimentation in curriculum and instruction. And at NSBA we don't believe in a one-size-fits-all approach. We think it is very important to allow for local flexibility so that those closest to the ground who are in our classrooms, teaching our students can stress particular priorities and values that exist within their own communities.

Ms. JEFFREY. You will notice in my testimony I did not say I didn't support national standards. What I mentioned is I didn't think this was the appropriate body to move towards that. I do believe that there probably is a time and a place, and this may very well be the time and place, by which there is some national consensus about what children or students should know and be able to do.

At the same time, I believe there must be a great deal of flexibility for states and local school districts to really be able to raise their expectations beyond perhaps what a national expectation

might be, but in that they should be voluntary, at least at the beginning, because it takes a long, long time to integrate into curriculum align curriculum and really do the work appropriately.

Chairman BAIRD. Do you feel that, Ms. Jeffrey or others, the work that has been done, I mean, we talk a lot about we need research, we need trained teachers. You have got some good models. I know our state does. Many other states are doing, many local school boards, and yet we seem to not believe that we can say, look. "You do it this way, it is working for you, can't we share that idea with another curriculum? Can't we look what the experts in mathematics are saying, and use that?"

But you are saying some other body might be the way or some other way to get at that.

Ms. JEFFREY. Well, what I am saying is, for instance, we have the Focal Points from the National Council of Teacher of Mathematics. I think it is a great document, and when we co-chaired, I co-chaired the CCS Math and Science Task Force, we referred to that document as something that should be basically a foundation for states to really look at as they constructed their own standards and their own curriculum.

So I think much of the work has been done, and we just need to draw a consensus across what this really needs to look like.

Chairman BAIRD. I am going to yield, we will get back, you will have a chance. Dr. Ehlers may follow a similar line, and I would yield, recognize him for five minutes.

Mr. EHLERS. Well, thanks for the introducing the topic. There will be another two hours on that.

It was just interesting listening to the different perspectives that emerge, and this is something that is discussed a lot around here. And I was impressed by your use of the word, chivalrous. I didn't realize you were an Old Testament scholar.

But, really, that is, I think, an apt description, because that is what it is in the Congress. Just, we, no national standards, no national standards, and I have introduced a bill on voluntary standards, and even that, everyone characterized it as a bill to create national standards, which it doesn't, but it certainly is a step in that direction.

The question I ask myself is, you know, there is a small town in southwestern Minnesota, roughly 1,000 population, and it is, the name is Edgerton. It has been around quite awhile, it was a farming community for many years, and you recall about 1880, 80 percent of our population was farmers. You get to 1920, or less, actually about 1907, you know, only a hundred years ago, it was still about 60 percent agriculture. It was very easy for the local board to decide on a good curriculum because there was very little movement out of the community.

But today that community sends people all over the world. I happen to come from that community. I meet friends from that community. One good friend who taught at Yale, another one who is teaching in Pennsylvania at a university. A lot of them are farmers, a lot of them have moved to Minneapolis, are working in the shops there, the factories.

It is a different world today, and to say that the local school board has to have final, absolute control over curriculum is thinking 100 years ago. I am sorry, Ms. Gayl, but it is a different world.

What makes it even more different now is our competition in the world with all the over countries. And if you look at the TIMS scores, the PISA scores, all the international scores comparing our high school graduates with other countries, then look at the list and look at who is at the top of the list, they are small, homogeneous countries who have the same program throughout the entire country. It just aids in teaching.

And as you know, I used to teach, and I also worked a lot with elementary schools and with the kids. First of all, Mr. Fennell, I thank you for bringing up the role of parents. It has always bothered me that all these reports we read ranging from a nation at risk onward, they don't mention the role of the parents, but in my experience working with the schools, the single biggest factor in the success of a student is to have at least one interested and involved parent at home. That is crucial.

But when you get to the curriculum, because of the mobility of the country, 1880, in Edgerton, Minnesota, if one percent of the population moved over the course of five years, that was news. That made the local newspaper. But today's world the average family moves every four years, and it is very easily possible for a student, a young child to be in a school in the fall semester and studying fractions in math, and then around Christmastime the family moves to another school system, which studies fractions in the spring. The student gets a double dose of fractions, but if these schools in their other semesters were teaching percentages or something like that, the student never learns it. It is absurd. There has to be at the very least we have to have uniformity of sequence, and I don't consider that national standards. I consider that national agreement. Let us accommodate to our changed world, people move, let us make sure they all get the same subject in the same semester so that when students move, it doesn't really matter.

That is particularly true in an urban area such as one I represent. I have talked to school principals. In fact, I was talking to one school principal once. He had a student who had transferred four times in one year, and it is possible in my particular area because of the structure a student can move within a one-mile area at most and still be in four different school systems with four different moves. We clearly have to address the problem.

And maybe you don't like my bill, maybe you don't like other proposals, but we have to address the problem. Now, I would be interested in hearing any—well, I can't. My time is up.

Chairman BAIRD. I will yield the gentleman additional—

Mr. EHLERS. Well, I gave the sermon. Now it is time for the call if any of you want to comment.

Ms. TRAIMAN. Business leaders couldn't agree with you more. As I said, it is absurd for each local community to make these decisions, but going in this direction doesn't mean each local community teaches everything in the same way. If a community is near a river, a community is near an ocean, a community is in an urban area, they may teach the same concepts in a very different way.

But the question before us is what role should the Federal Government have. So if there is agreement we need to move in this direction, the judgment that we have made is that right now if the Federal Government got involved, it would cause us to have more controversy and less consensus moving in this direction.

And so I am totally making this up but if you had a choice between the Bill and Melinda Gates Foundation moving this forward and the Federal Government moving this forward, and I have no insight into the Gates Foundation, the better direction right now in terms of our politics would be to not have the Federal Government involved.

Chairman BAIRD. So after November of next year presumably would be a superior time I would—

Mr. EHLERS. Well, since you said you were just making that up, maybe you belong in the Congress as a matter of fact. I think, let us just clarify this, and then I will yield.

I think the issue is sequence and concepts. If you get agreement on those, that goes probably 80 to 85 percent of the way. Furthermore, I don't want the Congress to make the rules. Our bill gives it to NAGBE. Maybe you have a better choice to make it, but I think the government should be out. We are just saying let us see if we can't develop a national consensus to at least have the same sequence and teach the same concepts in that sequence.

Thank you.

Chairman BAIRD. I think Dr. Ehlers and I are both of a position that, where if you are a parent and you move to another school district, you need to not feel like your kid is going to come out of sequence and similarly, if you are a teacher and you are moving to a different school area or you got trained in one university and you teach in a different state, you don't have to relearn everything. The inefficiencies of that for our economy and for our kids' learning strike us as just wasteful in a time when we can't afford to be inefficient in facing global competition.

Dr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. I have to say I am deeply appreciative of the discussion on national standards.

But Dr. Beering, I want to thank you for your efforts in preparing the NSB Action Plan. One of the central recommendations is the creation of a national council for STEM education. How do you respond to concerns that that would just create another level of bureaucracy? Is that something, I am sure that is something that has been discussed.

Dr. BEERING. Yes, indeed. In fact, of all the responses we have had, the very similar comments were received as we heard around the table this morning. I want to emphasize what we are recommending is a non-federal, independent body that would recommend and advise and stimulate and catalyze a national effort for content. And it is not a new bureaucratic instrument that would substitute itself for existing bodies that have those charges.

So we are not concerned that if the right people with the right attitudes, people that particular structure that they couldn't be very helpful to individual school boards.

I would emphasize that there are 14,000 individual school boards, so to get consensus among 14,000 school boards is hard to imagine.

I would like to add a university comment since I have the floor, and that is that the preparation of teachers is so crucial. I think we have all agreed that we want to have very well-prepared individuals. At my university of Purdue where I have worked now for 25 years, we establish the college of education which mandates that each student who opts for a specific field major in that field and has a major in the participating college. For example, a math teacher has to be a math major. That has been achieved with cooperation through the School of Science.

Another thing we are doing that is very unique, we guarantee our graduates so if a given school board is unhappy with our math teacher graduate, we will be happy to take him back and retool them.

Mr. MCNERNEY. That would be good in the medical profession, too. So—

Dr. BEERING. Right.

Mr. MCNERNEY.—thank you for that testimony, and I would say that since it is not a federal, it wouldn't be a federal bureaucracy, it wouldn't be paid for by federal taxes, which makes it more appealing to us at a certain level.

Dr. Fennell, I am a mathematician, so I appreciate you coming and the work that you have done. I share your desire to close the gap, the achievement gap, and do you think that the recommendations in the NSB plan will do that, will help close the gap, the achievement gap?

Dr. FENNELL. Well, I think that as you look at this thing called mathematics achievement in this country, we are constantly confronted with mixed messages. A week ago you read about the *National Assessment of Educational Progress Report* results where in mathematics we have the highest scores in grade four and grade eight that we have had in history and a continuing trajectory upward. At the same time we have high school students taking more, if you will, higher-level mathematics than at any other time.

At the same time, at precisely the same time, we are not nearly as competitive internationally as we would like to be. Report from the *American College Testing Bureau* indicates that far too many of the students who go to college are not ready for college mathematics, even though they have taken those higher-level mathematics courses.

If there is anything that causes this issue of coherence to rear its head, it is this story that I am trying to tell you. I mean, we are all over the place. You can't expect a fifth grade teacher to be knowledgeable about a hundred and some objectives and figure out which ones to emphasize when that child is then going to move in two weeks to another state and be placed in another curriculum with another teacher from another perspective.

And, again, I think the notion that is coming, Mr. Ehlers, I have heard your comments for years about the notion of voluntary curriculum that would allow us to consider what is really essential, and I believe we can get around those essentials. And then allow the kind of independence that we would support in school districts

that are unique in terms of particular environment, particular student clientele, and the like.

Mr. MCNERNEY. Thank you. Dr. Semper, I want to thank you for coming out from the Bay Area. I represent part of the Bay Area. You have talked about research and learning, what excites kids. How do you disseminate that to a more national body of teachers?

Dr. SEMPER. I can tell both maybe a local story and a national story.

Locally, this summer we had forums on elementary science education for the whole Bay Area. We brought together people from all the Bay Area districts, from the informal science centers of which there are five or six in the Bay Area, from the universities, to talk about what would a good elementary science program look like. And we had people present what is known from research, people present what is known for the various curricula that are being adopted, and we had a public forum, which had not only the representatives I mentioned, but also school board members and parents.

That kind of local opportunity to talk about education is very rare. People don't get a chance to do it in, I would say, a more neutral environment. When parents go to school, they are sort of in a situation where it is not a necessary comfortable environment to talk about the education for their kids.

So the idea of having local conversations about this I think is very powerful, and one could extend that to national conversations about the same thing. We don't really talk about what we mean about science education from the perspective of all of the players, and I think that is the kind of dialogue that is absolutely critical.

I might say what is interesting about this national council, of course there are a lot of issues about it, but there is actually no place where everyone can get around a table together in a fairly neutral way to talk about what we know and what we can do about things. It actually doesn't exist because most of the forums are driven by one party or another for very good reasons. There is no neutral place to do it.

But I would say the local—let me go back; I think the local conversation about science education, about any education in a community would be one way to actually move forward on this issue collectively.

Mr. MCNERNEY. Thank you.

Chairman BAIRD. Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman. And I thank you for calling this hearing, because it is very, very important, and it is something that has concerned me and I know concerns you as an educator to have a good panel like this to give us their background, their information on it, because it is kind of a battle going on for minds today and to what thrust we are trying to put them as they go to junior college or to a university. And how many of them steer clear of science and math, and it is a statistical battle that we are really kind of losing on engineers.

You know, STEM is an acronym, and it stands for, you all know what it stands for, Scientific, Teachers, engineering, Math, and it looks like it has science on one end and math on the other, and the

science to push the technology, and the math, the other end to push engineers. And let me just zero in on engineers right now.

It is my understanding that we are flat, internationally we are losing that battle. We may be training more of their engineers than we should be, but we, I think seem like we have, we graduated 100,000 or something like that, substantially fewer than even India does and not even a fourth of what China does.

Now, I don't know what type engineers they are turning out, but I think it is important, and I like that acronyms of science, technology, engineers, and math a lot better than I like the one NAFTA. We had a, you know, we have NAFTA, the A should have stood for act, but it doesn't. It stood for agreement, and I think they put it on there that way to where they wouldn't have to try to get two-thirds of the votes of the Senate to confirm some type treaty or something like that.

Anyway, both the Senate and the House passed NAFTA, and it has turned out okay. Of course, most of the foundations in my state have been built south of the Rio Grande than they are north of the Rio Grande, but that is part of the, I guess, overall plan for it.

But I was interested very much in Mrs. Gayl's testimony, and she talked about the lane between teacher quality and student achievement, and that is what we have got to tie. We have to tie those together somehow. Need a partnership of all levels of government, and I want to give the Chairman an awareness of in Texarkana, Texas, they have a school called Texas High, and we also have University of Texas A&M at Texarkana there. Those two institutions work closely together, and the voters of Bowie County where Texarkana is, voted to build a high school built around science and technology, science and math. And I don't know if you all area aware of that, but it is, I have dedicated and cut the ribbon to it and then I thought I was going to be there this last year as chairman of science, space, and technology, but I was there as the, what am I, Doctor? Ranking Member, not Chairman.

But, we, I had in mind attending this, being called Chairman when I was there, but it didn't happen.

Anyway, you talked about strengthening teacher preparation programs with universities. That is happening right today, and there is some real patterns to follow there. It goes on with, and I think you pointed out that teachers preparation programs ought to be aligned with existing state academic standards, and that is, of course, as you pointed out, No Child Left Behind requires that.

I guess the question I want to ask is how would we do that? Dr. Semper also alluded to it. I guess, Mrs. Gayl, how do you, what do you have in mind when you say that Congress can provide valuable incentives to improve teacher quality and spur local investment in STEM education?

This Chairman is doing that. He is pushing it. He has got it off and going. Now, what do we do, how do we do to bring them closer together? They brought them together up in northeast Texas because they have those students that are still in high school that are getting credits from Texas A&M in math and science. What are your other suggestions on that, Ms. Gayl?

Ms. GAYL. First of all, I would like to point out that some of the incentives provided for in the *COMPETES Act* in terms of scholarships—

Mr. HALL. Yes.

Ms. GAYL.—for students and also programs which at the university level partner the teaching component and the academic component to train teachers, you know, effectively in these subjects are very important. What I would say is that there needs to be greater coordination among universities and the programs in these universities with the local level.

You point out that this is happening in some areas, but in others there is a real resistance among the universities to do this.

But I would also point out as well that, well, and you highlight, Congressman Hall, that we are also very supportive of having some real accountability for teacher preparation programs, and we believe that they should be aligned, and they should be teaching what the state academic content standards are as opposed to national content guidelines, which is recommended by the Board. But it is a similar type of alignment that we are looking for.

Additionally, I just point out, though, that the majority of tomorrow's teachers are in today's classrooms, and so what we need is a very strong teacher preparation, professional development component as well, because it is not enough just to address the new teachers that will be being trained, but we need to work more effectively with the teachers that we do have.

Mr. HALL. Why the resistance from universities?

Ms. GAYL. Excuse me? I am sorry.

Mr. HALL. Why the resistance from universities? Now, I can see a resistance from anybody in high school. When I was in high school, I liked history and the only part about English I liked was when we had English literature. I wasn't too good on conjugating the verb to be, and I have never found a way to work that into conversation anyway since then.

Ms. GAYL. You know, I could only really—

Mr. HALL. And unlike Dr. Ehlers, I was not very much of a student. I made four Fs and a D on time, and my dad whipped me for spending too much time on one subject. So that is the type of student I was. Everything over 70 was wasted. So I am the kind of guy that really we need to be reaching out to to get them interested in science and mathematics and to fill out the word STEM.

Ms. GAYL. Uh-huh. Well, I think we would certainly be supportive of that. I can only, you know, speak from my experience, but in trying to work with the university community, you know, they are the protectors of free thoughts, and they don't like anybody telling them what to do. So that could be challenging, but I think one of the ways we might be able to bridge this gap, there are some really interesting programs for dual enrollment credit that are going on right now—

Mr. HALL. Uh-huh. Yes.

Ms. GAYL.—between high schools and colleges or also with community colleges in particular, and I think that those sort of partnerships can help to better coordinate our K through 16 system.

Mr. HALL. I think my time is up, but I think Mrs. Traiman also mentioned Norm Augustine, who is, I think, one of the really great

Americans, and I don't know why a guy like him can't be one of that bunch running for president right now.

I yield back my time. I don't know if he is a Republican or Democrat. I would like to know that. Like Dr. Ehlers suggested that you run for Congress. I would like to know where you live before I agree with that.

I yield back my time, Mr. Chairman. Thank you.

Chairman BAIRD. I thank my good friend. His modesty about his academic background, some of you know that, what was it, Ralph? Eighteen you were flying fighters off aircraft carriers. So he says that so we adjust. Exactly. Is today your birthday?

Mr. HALL. No, not really.

Chairman BAIRD. Oh, all right. But he raised a very good number of points.

Dr. Lipinski.

Mr. LIPINSKI. Thank you, Mr. Chairman. I wanted to start off by thanking Dr. Semper, I know you had thanked the government through us for what we had done to help you. I would like to thank you for the Exploratorium. I was a grad student, got my Master's degree out of Stanford, and I have been to the Exploratorium a few times. I love that place.

So I wanted to, if Dr. Ehlers could preach a sermon up there, let me take a minute or two to advertise a little bit. I think partnerships are a great idea, and one way to do this in a bill that I am working on introducing next week is to put in grants that go to partnerships between DOE labs and museums to work on projects that help STEM education, and so it is a bill for anyone who is here or watching, listening that I am planning to introduce this next week, but I think it is a great way to encourage partnerships between the energy labs and museums to help with STEM ed.

I think that partnerships between colleges, universities, and elementary and secondary schools are also very important. Partnerships with corporations out there, industry, I know that there is something that is coming up in my district. I have Bolken, who has quarries all over the country, is doing a program, bringing students from one of my local schools there. I think these are types of things that are really neat to encourage, and I also want to add that parents I certainly think are really probably the most important part of the puzzle.

But finding ways to get everyone to work together for STEM education I think is very important. I have a degree in engineering before, some say I went to the dark side and got a Ph.D. in political science, although I have to say that I use as much math in political science, in my research as I ever did as an engineer with statistics being so important.

So I just wanted to throw out there, Dr. Fennell had sort of touched on this a little bit. We are trying to make sure that all kids in America sort of have the basics that they need in STEM ed. How do we, how exactly, what suggestions do you have to encourage those who are going to take a particular interest, who are going to go on and be an engineer or mathematicians, how do you work with them early on sort of to encourage that beyond what, your other students who are not going to go into those fields? What, how do you do that?

I want to start with Dr. Fennell and anyone else who wants to comment.

Dr. FENNEL. It is a great question, one that I think is critical to some of the implications coming from the report. That is the issue of highly-qualified teachers, teachers who know their mathematics, teachers who are comfortable in their classrooms with the culture of their school, and are able to frankly see when kids are ready to move on, when kids, some kids might need additional support and stay right in that classroom. Some kids may need to be accelerated through at a rate, but that rate needs to be carefully monitored.

One of the things that we are seeing in this country, as I mentioned before, is movement to higher level of mathematics. By that I mean the courses that some of you had when you were in high school are offered earlier. And that is wonderful for the kids who are ready for that. Let us insure that they have that sort of critical foundation, that strong background before they are able to do that.

But the population you are talking about are the next engineers, that Mr. Hall referred to—the people that we want to turn onto this subject and find a way to keep them invested in it. That is not to say, as well that we want, when everybody comes out of that education an opportunity to value the subject.

Because of the time of the year it is, fall, and you see lots of people playing sports, I was struck by something; I saw four times within the last week. That is a whole bunch of parents cheering kids on playing soccer. Trust me. They know nothing about that game. And so I was thinking, jeez, wouldn't it be nice if they had the same sort of zeal and interest about something else that they may not know as much about as we would like them to be, to know, i.e., mathematics, but encourage them, allow them to play for the next team, allow them to travel, to be on the travel team and all that that offers and or allow them to get the support they need to achieve. I think it must happen.

Ms. JEFFREY. I would like to address your question also. We are working much earlier with our students beginning at eighth grade and in middle school to really think about their career pathways and putting together an eighth grade plan. This really establishes with their parents the goals that they hope to have for themselves and trying to keep them on track through their high school years.

We also have a large percentage of our juniors and seniors in high school attending community colleges courses or dual credit courses and linking those aspirations right into their post-secondary training, which begins to really attract individuals into post-secondary education that may never have gone there before.

We also have an initiative under way, and we haven't talked much about this, community college instructors. We really are in an effort right now in Iowa to raise the level of expertise and the quality of the community college instructors because more and more of our high school students are going into community colleges rather than into the four-year universities for lots of reasons: close to home, not as expensive, and also directly accessible to them.

So those are some of the efforts that we have underway to sort of create those seamless transition for students. We also have career academies that are occurring between our community colleges

and our high schools in Iowa, mass science career academies where students can actually go and attend classes different from their high schools, bioscience academies, pre-engineering academies. We are working to establish all of those kinds of hubs that students can attend beyond their regular high school courses. So there are ways to get this done.

Ms. TRAIMAN. One quick thing on that. Sadly for a lot of kids who might get excited, for example, about being an engineer, the door is closed very early, and it is because of math. Kids can get very excited about science. They can even get excited about engineering, but if they don't have success in the prerequisite math course, they are not going anywhere in engineering or in science, and we really need to put more focus on making sure that math doesn't close those doors. Even though we are doing better on NAEP in math, we are not doing well enough.

Mr. LIPINSKI. Thank you.

Chairman BAIRD. We will do a brief second round of questions if we may.

Dr. Beering, you have specifically spoken about a non-federal proposal and yet the response from other panelists is grave concern that that might nevertheless become some new bureaucratic mechanism.

I guess my question to the panelists would be, and Ms. Traiman, you mentioned that in effective, 14,000 different systems is not really a good way to go if you have got a national interest in a skilled workforce. And yet you are suspect of a federal panel for reasons you obliquely describe as political but for some reason don't want to go into operationally what that means.

But if not the approach described by NSB, which is particularly specifically not a governmental entity, what approach do we use to try to get greater coherence and coordination, both vertical and lateral? What alternative approach might work better than what NSB with the effort in this document has come up with?

And by the way, other than Bill and Melinda Gates because I am familiar with them. They do great work, but there is a fair bit of bureaucracy there, and they would still have to get 14,000 school boards to somehow buy in. So there is no magic bullet out there, but what is a better approach?

Ms. TRAIMAN. One of the things to learn from the past is that there have been efforts both governmental and non-governmental to establish voluntary national standards in the subject areas. Some of them produced good products. Some of them, you know, went by the wayside because they weren't very strong. But one of the serious problems they had is that the people who have an interest in each subject area loaded up with more than can fit in a single school day. So there is no time left for history or English or foreign language or any of the other subjects.

So one concern about this entity is that if it is only purview is STEM, it doesn't have to make the critical tradeoffs of not just what scientists and people in that field think is important, but what in a school year or school day makes sense.

Chairman BAIRD. Very good point.

Ms. TRAIMAN. That is one problem. The political problem is this in terms of any federal funding for it right now. Deciding what is

important for students to know and be able to do brings in value judgments, and these will have to be made no matter what political entity or whether it is government funded or not government funded. But if this starts out federally funded, you get situations where Members of Congress may introduce amendments saying such and such can't be included in this, you know, restricting from the get go. If we approve creation of this, it can't address this particular subject in science.

And that is the concern. It is not Republican and Democratic politics.

Chairman BAIRD. It is the system of representative government itself.

Ms. TRAIMAN. Right. Which——

Chairman BAIRD. I see——

Ms. TRAIMAN.—the alternative is——

Chairman BAIRD. This hearing stands adjourned.

Ms. TRAIMAN. I guess I am not running for Congress. The alternative is actually something that is happening right now. There is a voluntary association of states working with an organization called Achieve. Its board is half Governors and half CEOs, and they are starting at the end point saying when a student graduates from high school, what does that student need to know and be able to do, they are starting in reading and math, to be ready for post-secondary education and the 21st century workforce.

And then from that endpoint they are back mapping what would that mean in tenth, eighth, you know, every single grade essentially back to kindergarten. It is a long process, and each state right now is doing on its own, but they are now, they made a decision in about nine of the states to develop a common end-of-course Algebra II test. Nobody from the government is telling them to do it. They just realize it is cost effective to go in that direction. Algebra II in Washington State isn't different than Algebra II in Michigan.

And so one way for the Federal Government would be to provide incentives for states to move in that direction rather than giving this to a federally-funded entity at this juncture.

Chairman BAIRD. Dr. Beering.

Dr. BEERING. As you think about the people who would make up this council, it would look a whole lot like this panel, and so I would ask my colleagues at the table here what can you imagine that would incent the average American family and the average American parent to get with it and to have its students and its kids get excited about science, math, and the international competitiveness? What do we have to do?

Dr. FENNELL. I think the potential of the non-Federal Government panel that you suggest has the potential, as you say, to get people who are connected with, if you will, the informal science education or mathematics education or science education and or those other fields to think about what would be important. NCTM regularly works with Achieve. We are very aware of what, of their work with nine, actually that, I believe, has now grown to 13 or 14 states, who are thinking about a common Algebra II test.

However, I would say that not, even though people teach this thing called Algebra II in a lot of different ways, there is not nec-

essarily a universal definition of what that is. It is not as simple as it sounds, but the point is that people are willing to come to the table and think about what is important for all kids. And that also goes back to Susan's question earlier, and that is if, in fact, we see mathematics as a roadblock for certain kids as they think about ending, considering science-intending careers, then we need to find ways to kind of work toward opening that gate for all kids, because everybody is in the classroom.

Mr. HALL. Would the gentleman yield?

Chairman BAIRD. Sure. Be happy to.

Mr. HALL. I might ask you why do they keep teaching all that stuff in math? You know, you are in the war, as a Navy cadet we had ground school, and I always had a course in celestial navigation, and it washed out more pilots than not being able to land on a carrier did. Washed out I would say two-thirds of the pilots, that one course did.

So you have, golly, geometry, pure math, trigonometry, calculus. Why don't you quit teaching all them hard courses, and you would get more of us interested in math?

Dr. FENNELL. Can I respond to that?

Mr. HALL. I wish you wouldn't. I am just trying to fix some way—

Dr. FENNELL. I was going to give some of your language back to you.

Mr. HALL. I am trying to get some way that youngsters get interested in math, and we have to, folks like you have to entice them some way.

Yes, please, go ahead.

Dr. FENNELL. Well, it comes back to something I said earlier in the testimony, and that is it is really important that we get parents and frankly—

Mr. HALL. Absolutely.

Dr. FENNELL. I mean, there is a popular book going around right now called, "Math Doesn't Suck." Well, you know, there is something wrong about the message there. Anybody who has ever been in a classroom and has had the parent sit down with them at the parent-teacher conference and say, you know, I was never good in math either, well, that is not the point. The point is this subject unlocks doors. It allows Mr. Lipinski to use an engineering background in the halls of government. It allows people to fly planes, think about big ideas that might be situations involving chemistry and all kinds of other things.

Now, my problem is I represent 100,000 teachers around this country is to make sure that kids not only get that, but find out that it is something that is of value to them. If it going to be easy necessarily? No. And by the way, I don't think that is a bad thing. There is a lot of things that we do that are hard, and you come out the other side of that realizing, you know what? That was really good that I did that. And that is where we want to be I think with all this.

Mr. HALL. In soccer I was watching my eight-year-old granddaughter play, and the ball went right off to the soccer goal there, and I said, kick it in, babe, kick it in, babe, and she looked at me with her hand on her hip and her lip out, and growled at me, you

know, and looked at me. Somebody else kicked it out, took her out, and I walked over, and I said, why didn't you kick it in? She said, Paw Paw, you don't know anything about soccer. It wasn't my time. I took her right out to Wal-Mart, and we got a soccer ball and a goal. So she needed some pure math, I guess.

Dr. FENNELL. That is right.

Mr. HALL. Thank you. I yield back to time I didn't have.

Mr. EHLERS. Thank you very much. That is tough to follow, but I do want to build on something that Mr. Hall said earlier.

The—when he referred to China. I take, what I sense here and what I have sensed among the American public, they don't understand the urgency of this situation. China and India decided about 20 years ago that they had to do this for economic survival in today's world, and they went, and it is easy for China. It is a totalitarian system. You will study math. And so they did it, and they have done very well.

In fact, last year China graduated more English-speaking engineers than the United States did. In addition to that, they graduated six times as many as we did, whereas 20 years ago they graduated half as many.

There is a real urgency to this, and we can't dither around and say, well, you know, we will try this, we will try this, we will try that.

That leads up to a question. I gathered some of you are very concerned about the national council, and I also heard a number of comments, we don't want the government running this. I would simply point out that in the same time many of you praised the post-Sputnik activity, National Defense Education Act, and so forth, these were government-run programs. You can't rule out the government per se.

Now, I am not a great fan of the government running it, but there has to be some cohesive mechanism to pull this altogether and get it done. Right now we are getting, some of you mentioned community college. Right now community colleges are doing more to save us than any other educational entity, because they are making up for the deficiencies in the elementary and secondary school and serving as a springboard to the colleges and university.

But the question is, you know, if you don't want the Federal Government to do it or if you don't like the council, what would you like better?

And Ms. Jeffrey, you are a trained administrator. Would you feel better if you were running it? Do you think it would be a good idea?

Ms. JEFFREY. Well, I have to tell you that K-12 educators are very interested in doing the right things, and the Chief State School Officers have been in this discussion for over a year and are very interested in working together to sort of create this common framework. But having the people who are most impacted by these decisions as part of the process is absolutely crucial.

Mr. EHLERS. Uh-huh.

Ms. JEFFREY. And that is, I mean, the Chief State School Officers are involved in this discussion. They are the representative of each of the states who are charged with the responsibility for K-12 edu-

cation in their states, along with their governors, and really want to take a very active role in this discussion.

So we would much prefer that bodies that represent us are very actively involved I guess is the best way to put it.

Mr. EHLERS. Won't the school boards feel the same way?

Ms. JEFFREY. Well, I am sure they do.

Mr. EHLERS. My real question is how do we coordinate? We have no desire to impose this. I don't think the Congress or the Federal Government wants to impose it, but there has to be an action mechanism and a guidance mechanism. And the urgency has to be imparted to the people.

I just wrote an article which appeared Monday in my hometown paper, and I understand the Hill picked it up and put, has it on their blog if you want to read it. Its title is "Where is Sputnik When We Need It." Because we really need another Sputnik now and to provide the national energizing and collaboration.

I may be interested in any other ideas you might have that would help us.

Ms. GAYL. I would just point out that at the National School Boards Association we are not opposed to a federal council in this regard. We think it could be particularly helpful in coordinating the various programs that exist throughout the Federal Government, and we think it can provide some very real great tools and resources. And we are also supportive of the idea of content guidelines.

What we are concerned about is this being perceived as a sort of top-down approach that would be telling school districts and states what to do, and so I think we need to, you know, tread carefully in this area, because in order for a movement like this to really take place, it needs to start with the parents, with the local communities, and they have to buy into the plan.

And I think that there are some real ways that we can do this to incentivize folks at the local level to do that, but we certainly wouldn't want to see a bureaucracy or entity created out there that wouldn't report to the Federal Government, that wouldn't report to the locals, that wouldn't report to the states, that would be perceived as telling people in their communities what they needed to learn and to know.

Mr. EHLERS. Well, I don't think any of us want a tell-down system, but we do need a top, and the real question is is how can we pull this together? How can we energize it? How can we get it moving?

And you know, what we really need, and this goes along with Mr. Hall's comment about why the pilots flunked out, they had to learn celestial navigation. Today we use GPSs and so forth. But what you really need is a top and a guidance mechanism.

Now, you don't need a force mechanism, but you do need a guidance mechanism. So whatever you can do to help us put this together we would appreciate.

Thank you. I yield back.

Chairman BAIRD. I think we have done the inverse of No Child Left Behind.

Mr. HALL. Mr. Chairman, I think I have exhausted my time, but I just tell this group here how fortunate we are to have people like

you that will give your time, that have prepared yourself to bring you to thing point, and we are very fortunate to have Dr. Ehlers on this committee, knowledgeable, with background that is unbelievable, and Dr. Baird of academia that is above and beyond.

So you have some good things going for you up here, and we really do, I personally appreciate each of you giving your time it took to get here, the time to prepare, and the time to go home.

I yield back my time.

Chairman BAIRD. Very well said, Mr. Hall. I thank the panelists. This is such an important issue, and we could go on at great length. The sense clearly is that there is an absolute commitment, and some great people doing some really great work, and one of the paradoxes is here we are with this fantastic country that is acknowledged as a world leader, really sound people like we see before us today, and yet when it translates down to our average child out there in the field, they are not necessarily getting the level of achievement that we want.

And what we are trying to do with this series of hearings that we are having on this committee is tap into the expertise and knowledge and real-world experience of folks such as yourself and try to figure out where best to go.

And I thank all of you. I thank NSB for the great work and all the people who participated in this presentation. But it is so valuable to have further insights into the pros and cons of what has been proposed. This is not by any means the end of this. As you saw with the *America COMPETES Act* and the leadership of Chairman Gordon, the Chairman of the overall Science Committee, and the leadership of Nancy Palosi is absolutely committed to improving our education opportunities for our kids.

We intend to actually operationalize some further measures that will actually continue to move this forward. My personal commitment, and I believe that of all of our colleagues is that every child born in America will have an opportunity to have the top quality science education, science and math education regardless of where they are born, with quality teachers, with curricula that makes sense, and with career paths that are linked in some ways to the curricula and teaching that they receive along the way.

And we believe that there is an important federal role because it is of our national interest to accomplish this. It is not enough for us as a representative of the United States Congress to say, well, there are 14,000 school districts, some are going to get it right, some are going to get it abysmally bad, and if your kid happens to have the good luck to be in those districts where they are getting right, terrific for you, and too bad for the other kids and too bad for our country that we have lost those kids' contributions.

So finding a way to balance that is our goal, and your insights today have helped us move towards that. I thank our panelists, and with that we, you just heard that the vote has been called, so that is timely. And with that this hearing stands adjourned with the gratitude of the Committee.

[Whereupon, at 11:50 a.m., the Subcommittee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Steven C. Beerling, Chairman, National Science Board

Questions submitted by Representative Vernon J. Ehlers

Q1. We heard testimony from NSF not too long ago (following the release of the ACC report) which indicated the agency believes that the subcommittee on education under the NSTC is sufficient to carry on the work of the ACC. Your report recommends that the subcommittee of the NSTC be elevated to a full committee. Can you explain how this would change the power, perception, or function of the committee?

A1. The Board feels that the critical importance of STEM education to the Nation merits attention at a full committee level. At a full committee level coordination of STEM education would receive more direct attention from the heads of agencies, an increased level of staff support, and a more impactful position for coordination of federal STEM activities within the Administration.

Q2. Most of your recommendations rely on the National Council to take a lead in activities. Who do you anticipate providing the necessary sustained leadership?

A2. In order for the National Council for STEM Education to be effective, its non-federal members will need to assume joint responsibility for the Council's success. The Board recommends that the initial co-chairs of the Council be a State governor and a chief State school officer. Strong leadership by the initial Council co-chairs and a significant commitment by the Council staff will be essential to the success of this Council. Our Action Plan has requested a seat for the Board on the Council to demonstrate our support of and long-term commitment to this effort.

Q3a. Independent of legislation, what are the NSB's next steps?

A3a. The Board is committed to sustained support of this Action Plan and will continue to provide advice to Congress and other stakeholders as requested. In its role as the oversight and policy-setting body for the National Science Foundation (NSF), the Board will oversee NSF's implementation of our guidance to it in the Action Plan, beginning with a presentation by NSF on this subject at the Board's December 2007 meeting.

Q3b. Do you plan to revisit/revise the idea of a National Council?

A3b. No. The Board feels its recommendation and general outline for a National Council for STEM Education are of sufficient detail to allow Congress to charter such a Council without interfering with Congressional discretion to structure the Council as it deems best.

Q4a. Is there any entity on which to model the independent council that provides comprehensive coordination?

A4a. Currently there is no national coordinating body for STEM education; however, a few potentially instructive models do exist.

First, the National Council for STEM Education could be viewed as a national version of a State P-16 (or P-20) council, which many states have in place. In some states, P-16 councils have been effective policy mechanisms for coordinating among a state's early-childhood, K-12, and higher education systems and among local business and industry, school systems, and the community at large—in effect drawing all stakeholders together. Effective State P-16 councils, for example, allow local education agencies to coordinate their high school curriculum with entrance requirements for a State's institutions of higher education and with what employers expect high school graduates to know.

Second, at the national level, Achieve, Inc., a non-profit organization led by State governors and business leaders, is an example of how states can work together voluntarily on K-12 education issues. Although not STEM focused and not inclusive of all STEM stakeholders, Achieve has been successful in providing a structure for a substantial number of states to voluntarily adopt common K-8 mathematics standards and, through the American Diploma Project Network, to increase high school graduation standards.

Finally, the Transportation Research Board (TRB) of the National Research Council could be an instructive model from another field. The TRB has a mission to "provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multi-modal." It provides "opportunities for information exchange on current

transportation research and practice; management of cooperative research and other research programs; analyses of national transportation policy issues and guidance on federal and other research programs; and publications and access to research information from around the world.” The members of the TRB represent many stakeholder groups, and the TRB is funded by contributions by all stakeholders.

Q4b. How does this body acquire the respect of the classroom teacher and partnership of the local school district?

A4b. The Board’s recommendation is that the National Council would have a practicing classroom teacher and representative of a local school board as permanent members of the Council, ensuring that these perspectives are always present on the Council.

Q4c. Would this entity really be the first of its kind?

A4c. Yes.

Q5. It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by all stakeholders.

A5. In a truly coordinated system of STEM education, a student would have the opportunity to master, in a systematic way, key concepts in STEM learning. In addition, STEM teachers would be thoroughly prepared during their pre-service training with both the content knowledge and pedagogical skills needed to be effective teachers and kept up-to-date in that content knowledge with continual, relevant professional development. In a coordinated system, the K–12 system, the higher education system, and business and industry would all work together to ensure that students are provided with high-quality and up-to-date STEM content. In addition, parents and the informal STEM education community would be heavily involved in encouraging rigorous STEM teaching and learning.

Questions submitted by Representative Ralph M. Hall

Q1. In your testimony, you state that “the Federal Government must do a better job of coordinating its own STEM education activities.” How well is this currently being done within NSF? How does the EHR directorate interact and coordinate with the STEM education activities within the RRA directorate divisions?

A1. In its guidance to NSF in the Action Plan, the Board states that the EHR and R&RA Directorates should be doing a better job of coordinating their STEM education efforts than is currently being done. The Board will be following up with the NSF leadership on this issue beginning with its request for a presentation by NSF to the Board at the Board’s December 2007 meeting. As outlined in a January 31, 2007 letter from me to Congressman Holt (who asked that the Board examine this issue), the Board has begun a significant effort in the past year to review the evaluation mechanisms for and results of NSF’s EHR programs so that these findings may be used to enhance EHR programs within the EHR Directorate, across the R&RA Directorates, and in the context of the Nation.

Q2. You mention that some public comments expressed concern that National Laboratories weren’t given an adequate role in the process. Should the National Labs be involved at all, and if so, what should their role be?

A2. In response to concerns from the National Labs, the Board added to the final version of the Action Plan an explicit statement that the National Labs be included with other relevant federal agencies on the Office of Science and Technology Policy’s NSTC Committee on STEM Education to allow them to coordinate their efforts within the Federal Government. The Board also added a statement in the final Action Plan noting that the National Labs “. . . provide content expertise that could be effectively utilized to improve STEM teacher preparation.” This content expertise could also be utilized for professional development of teachers already in the classroom.

Q3. With regard to the concern that not enough is being done to get colleges of arts, sciences and engineering to collaborate with colleges of education in preparing STEM teachers, do you think that Congress has adequately addressed that concern in the America COMPETES Act?

A3. Although the Board is supportive of many of the measures taken in the *America COMPETES Act* and congratulates the President and Congress on enacting this leg-

isolation, it remains concerned that without a coordinating mechanism, the scattered programs outlined in the legislation will not be adequate to stimulate a significant transformation of the Nation's STEM education system.

In the case of the programs for baccalaureate degrees in STEM with concurrent teacher certification at the Department of Education (Sec. 6113) and the Robert Noyce Teacher Scholarship Program at NSF (Sec. 7030), the *America COMPETES* language does attempt to promote collaboration between colleges of education and colleges of arts, sciences, and engineering. Although this is a good step, encouraging such collaboration is an issue that needs to be addressed not only within individual teacher preparation programs at institutions of higher education, but across the system. A national coordinating body such as recommended by the Board would be extremely useful in ensuring that lessons learned from these two programs are disseminated and inform the development of other programs.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Judy A. Jeffrey, Director, Iowa Department of Education, Representing the Council of Chief State School Officers

Questions submitted by Representative Vernon J. Ehlers

Q1. Sometimes it can seem that states want the Federal Government to provide funds with “no strings attached.” What are the reasonable guidelines to attach to federal STEM funding? With many states undertaking STEM education efforts, is there any alignment from state-to-state with these initiatives? How do we get beyond each state doing its own thing?

A1. States believe and understand that guidelines must be attached to any Federal Government funding, as states attach guidelines to money they allocate to districts and schools. States embrace accountability as an important tool in education reform and believe STEM funding should be tied to outcomes for students. Reasonable guidelines would not prescribe simply one test that would be the measure for success, but allow for multiple ways to measure learning and progress that are valid and reliable. States do not believe that the Federal Government should attach provisions to funding that dictate a narrow way to accomplish the goal of improving STEM education since a one-size-fits-all system will not serve the needs of all students and school circumstances. States need the flexibility to continually innovate to meet local needs.

States are working to create more aligned STEM education systems. Thirty states are part of the American Diploma Project Network to align K–12 curriculum, standards, assessments, and accountability policies, including those for STEM education, with the demands of college and work. Thirteen states are also working with Achieve, Inc. to develop specifications for a common end-of-course exam in Algebra II. States also coordinate their STEM activities through grants they receive from organizations such as the National Governors Association and the National Math Science Initiative. All of these opportunities involve State information-sharing and collaboration to produce the best STEM education programs and systems possible. Creating more opportunities for states to collaborate, while giving states the room to adapt to meet their individual contexts, can help continue to bolster alignment on STEM education between states.

Q2. Going along with a National Council concept, how could states be more involved (beyond those described in the report) in the development of content guidelines?

A2. CCSSO supports voluntary, shared standards among states. States are also interested in developing shared standards in other areas besides math and science and would prefer that all of the voluntary standards be created in a manner that facilitates joint dialogue and a comprehensive approach. Having separate groups develop voluntary standards could lead to fragmentation whereby 21st century skills are not embedded within the academic subject areas.

Q3. Can you expand on your statement that the Council could determine “what the intent of STEM education” is?

A3. We must have a larger discussion on how to embed mathematics, science, engineering, and technology skills across the curriculum to create meaningful, deep learning experiences that will replicate real-world STEM experiences. Creating stand-alone content guidelines that do not address how to teach and integrate STEM education will not transform STEM teaching to the extent that is needed. It is crucial that students, regardless of the career pathway they choose, be afforded learning experiences through real-world, relevant learning activities.

Q4. Are your concerns about the Council solvable through changing the way it is chartered, led and funded? Do you identify with the unmet need that the Board is trying to address through the Council? If so, do you have an alternative vehicle to suggest?

A4. States identify with the unmet need the Council is trying to address of providing better coordination between STEM education programs. In particular, as I mentioned in my testimony, I see the most critical roles of the Council as increasing coordination among federal agencies and programs and supporting and communicating more STEM education research that is useful to educators and policy-makers.

Q5. Is there any entity on which to model the independent council that provides comprehensive coordination? How does this body acquire the respect of the classroom

teacher and partnership of the local school district? Would this entity really be the first of its kind?

A5. I do not know of any.

Q6. *It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by stakeholders.*

A6. The body should be composed of respected members in the field who are empowered to oversee and establish accountability provisions for the coordination of efforts across the Federal Government. It would even better serve the states if the body would reach beyond coordination to a process whereby duplication would be eliminated and efforts would be coordinated and integrated to meet the needs of states.

Questions submitted by Representative Ralph M. Hall

Q1. *You mention in your testimony that you would prefer that limited funding be invested in improving the quality of teaching versus assessments. How would you go about improving the quality of teaching with limited resources?*

A1. Limited federal funding will never be able to reach all teachers in a state. However, we have found that the dollars set aside for Reading First have served our state very well. The federal funds initiated the conversation on improving children's early literacy skills by providing start-up costs and requiring evaluation of results. Thus, the state developed a plan, worked with a few schools, modeled what should be done to change teaching practices, monitored implementation, and tracked student data. This process in Iowa was scaled-up to include more schools, through individuals that were trained in the original design with State and local funds. STEM teaching could be improved through a similar approach of providing targeted funds to improve teaching.

On-going, in-depth, on the job professional development will hold the greatest promise of improving teaching and learning in STEM education.

Q2. *You express some skepticism about a national council creating more bureaucracy and that federal funding may be better spent helping states implement innovative ideas. Please expand upon Iowa's high school reform efforts to create "teaching approaches that develop authentic intellectual work on the part of the students and teaching strategies that engage students in relevant and meaningful tasks and high levels." Is this program currently receiving federal funding, and if so, through what program?*

A2. The Iowa Department of Education has engaged in a professional development effort to enhance the instruction that high school content-area teachers use in their classrooms. The professional development effort provides training and ongoing technical assistance to teams of teachers from high schools in Authentic Intellectual Work developed by Fred Newmann (Emeritus Professor of Curriculum and Instruction, University of Wisconsin-Madison and former director of the National Center on Organization and Restructuring Schools) and colleagues. This instructional model sets standards for teaching academic subjects that:

- maximize expectations of intellectual rigor for all students
- increase student interest in academic work
- support teachers taking time to teach for in-depth understanding rather than superficial coverage of material
- provide a common conception of student intellectual work that promotes professional community among teachers of different grade levels and subjects, and,
- most importantly, equip students to address the complex intellectual challenges of work, civic participation, and managing personal affairs in the contemporary world.

The instructional model focuses on student construction of knowledge through disciplined inquiry to produce discourse, products, and performance that have value beyond high school. At present, there are teams (administrators, teachers, and regional support personnel) from nine Iowa high schools participating in this endeavor. The goal is provide access to the professional development to all high schools in Iowa by developing a cadre of experienced in-state trainers using qualified partici-

pants from the 2007–08 effort and from the 2008–09 effort, which is planned to engage another 30–40 high schools.
This model is being supported through a direct State appropriation.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Francis (Skip) Fennell, President, National Council of Teachers of Mathematics

Questions submitted by Representative Vernon J. Ehlers

Q1. Is there any entity on which to model the independent council that provides comprehensive coordination? How does this body acquire the respect of the classroom teacher and partnership of the local school district? Would this entity really be the first of its kind?

A1. I think such an independent council could resemble but have a different focus from the Mathematics and Science Education Board (MSEB) which operates within the National Academies of Science. I think the Conference Board for the Mathematical Sciences (CBMS), which represents ALL mathematics societies/organizations in this country in the area of mathematics and includes several mathematics education organizations (National Council of Teachers of Mathematics (NCTM), National Council of Supervisors of Mathematics (NCSM), Association of State Supervisors of Mathematics (ASSM), Association of Mathematics Teacher Educators (AMTE), and others) could serve as a resource for mathematics participation for such an independent council. I would think that a similar “umbrella” “Conference Board” for the sciences, engineering, and technology probably exists and would provide sources for potential council members. I believe the proposed council should involve educators at every level, this would include, from my field, mathematics teachers, mathematics supervisors, mathematicians, and mathematics educators. In short, with proper balance and a plan for meaningful involvement the independent council could work—and, is needed.

Q2. It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by all stakeholders.

A2. I can envision a Coordinating Council, with rotating leadership, that would include representatives from the major science, technology, engineering, and mathematics organizations in this country. I would ensure (bias here is noted) that teacher organizations (NCTM, NSTA) are well-represented on the Council. As noted, above, I think a sort of “expanded and re-focused MSEB” (see above) could provide a template for organization. I think “layers” of responsibility would allow for inclusion by all stakeholders from STEM, with designated “sub-committees” with each particular areas of focus (e.g., Pre-K–12 STEM education, teacher education, etc.). Hope this provides at least a “seed” for thinking about council organization.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Chrisanne L. Gayl, Director of Federal Programs, National School Boards Association

Questions submitted by Representative Vernon J. Ehlers

Q1. As I understand it, the goal of national content guidelines are to help teachers know what their kids need to learn and when. Do you have any input on the struggles of how we get beyond an over-packed curricula and the mobility of our students? Do you think that some coherence could be useful to the students?

A1. Certainly in today's education system, choices need to be made about what students should know and be able to do, and when. Given the plethora of content that exists, the limited school day, and a host of other factors, it is necessary to set priorities and make tough choices. The real issue is not that we must choose, but rather who is responsible for doing it. NSBA believes such decisions are best left to State and local authorities who have the constitutional authority over education.

NSBA believes efforts to align State standards and ensure greater coherence among subjects and grade levels would be useful for students as well as practitioners. An independent council could help to coordinate efforts between states so that they can learn from one another and find commonalities that may exist. However, we caution against a one-size-fits-all national model or curriculum that could stifle innovation and creativity and dismiss the geographic, cultural, and economic differences in the United States. NSBA believes that diversity among students' educational experiences play an important role in fostering a range of talents and multiple levels of knowledge that are important in a democratic society. Furthermore, we are mindful that most mobility among students occurs within states, and do not see this as a compelling reason to adopt a uniform system of education.

Local school board members value states' efforts to convene content specialists, representatives of higher education, and practitioners to lend their expertise and make recommendations about content guidelines and benchmarks. NSBA recognizes that in the areas of math and science, in particular, there may be a greater level of agreement on content than in other disciplines, such as in history where there may be moral and/or ethical concerns about the interpretation of events.

Q2. Is there any entity on which to model the independent council that provides comprehensive coordination? How does this body acquire the respect of the classroom teacher and partnership of the local school district? Would this entity really be the first of its kind?

A2. In establishing an independent council, we can learn from past coordinating efforts as to what is important and useful. In order to acquire the respect of teachers and work with local school districts, NSBA believes that a national coordinating body must:

- Recognize that education is primarily a State and local function for which the federal role should be one of support and assistance rather than direct regulation.
- Involve the participation of local governing officials and practitioners that are responsible for the day-to-day education of students.
- Have substantial knowledge and understanding of our system of government as well as the impact of and interplay between local, State, and federal policies and programs.
- Support, promote, and advocate on behalf of public education at the national, State, and local levels.
- Encourage and promote collaborative efforts among all levels of government, federal agencies, and the Nation's educational organizations and support groups.
- Recognize the cost of all federal education programs on local school districts and the costs associated with implementing federal mandates.
- Neither mandate or coerce states into adopting specific standards or assessments; or penalizes states that do not wish to adopt specific standards or assessments.

While this list is not exhaustive, it does lay the groundwork from which to build on what would be necessary in the creation of any independent body that would be tasked with comprehensive coordination of our education system.

Q3. It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by all stakeholders.

A3. NSBA supports a model that would enhance the coordination of STEM programs and enable opportunities that will enrich teaching and learning in these fields. Such an entity must include all relevant stakeholders and value the traditional role of states and local government in education. In addition, NSBA stresses that this model include substantial representation from outside of academia that are responsible for the day-to-day education of students and implementation of programs.

NSBA believes that the primary functions of this entity should be: the coordination of various STEM programs and initiatives throughout the Federal Government and among states, dissemination of best practices in the field, development of tools and resources that educators can use to improve instruction, and creation of a high-level public information campaign about the importance of STEM education. In NSBA's view, the role of this body would be largely informative and not involve direct policy-making.

The Federal Government is in the unique position to assemble the profound knowledge base that exists within these disciplines and to disseminate information on a national scale that can help to strengthen STEM education throughout communities. Additionally, Congress can help to provide valuable incentives and resources, outside of the creation of a coordinating entity, that can improve teacher quality and spur local investment in STEM (See answer to next question.)

Question submitted by Representative Ralph M. Hall

Q1. Please describe what you have in mind when you say that "Congress can provide valuable incentives to improve teacher quality and spur local investment" in STEM education.

A1. NSBA supports an array of incentives to recruit and retain teachers in high-need STEM subjects including performance-based pay, hiring bonuses, alternative certification programs, and student loan forgiveness. The Federal Government can help to encourage the creation and expansion of these strategies through pilot programs and funding to support states and school districts that wish to implement these policies.

In addition, NSBA agrees that Congress should help strengthen teacher preparation programs within universities to ensure appropriate alignment with academic standards and foster greater accountability among these programs. We suggest that teacher preparation programs be aligned with existing State academic standards, which all states are required to have in place under No Child Left Behind. More attention should also be given to developing and bringing-to-scale high-quality professional development programs for existing teachers. These programs can play an important role in updating teachers' knowledge and skills in their subject area and have been shown to have a positive impact on teacher retention.

Lastly, Congress can help school districts to leverage local resources by helping to provide funding for up-to-date laboratory equipment and modern classrooms, which are necessary to successfully implement a relevant STEM program. These facilities are essential for students to be able to experiment, create, and get a hands-on feeling for what the world of work is like in these fields. This scale of modernization, however, typically requires a large infusion of capital and often local resources are not enough to ensure that classrooms are appropriately outfitted for high-level STEM instruction.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Robert J. Semper, Executive Associate Director, The Exploratorium, Representing the Association of Science and Technology Centers

Questions submitted by Representative Vernon J. Ehlers

Q1. Is there any entity on which to model the independent council that provides comprehensive coordination? How does this body acquire the respect of the classroom teacher and partnership of the local school district? Would this entity really be the first of its kind?

A1. One possible model would be the existing state PK–20 or P–20 education councils. Made up of a diversity of education stakeholder, some of these councils have succeeded in bringing coherence to the diverse educational system. They gain respect by the careful inclusion of all of the relevant stakeholders in a situation where no single special interest can dominate the discussion. As far as I know there has been no equivalent version of a STEM focused P–20 council at the federal level.

Q2. It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by all stakeholders.

A2. A successful model would imply the creation of mechanisms for the various parties to find their proper and desired role in the conversation. At the federal level, a coordinated approach would require the various federal agencies to develop a coordinated work plan or roadmap for research and implementation. One successful example from the world of science and engineering that I know the subcommittee is familiar with is the coordination function that the National Nanoscale Initiative provides. The NNI has been very successful in creating a roadmap for the country for the development of nanotechnology research and implementation where the different parts of the research enterprise can find a home. The creation of this roadmap took both a vision and a significant series of discussions with all of the stakeholders to create a place for everyone. This led to significant support by all of the stakeholders because the vision made sense as a whole. Of course doing this on an issue like education with its federal, State and local components would be more difficult. Nevertheless I think that this kind of engineering approach to the problem might be needed.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Susan L. Traiman, Director, Education and Workforce Policy, Business Roundtable

Questions submitted by Representative Vernon J. Ehlers

Q1. Your testimony shows you have “been down the road before” on trying to align STEM standards. What do you think would need to change for national content guidelines to be beneficial instead of counter-productive? Is there anything within our grasp, or do you see this as unattainable in the next decade?

A1. In 1996, to help break the deadlock over national education standards, America’s governors and business leaders created Achieve, a voluntary effort to raise State academic content standards, better align those standards with the demands of the modern workplace and post-secondary education. Working through Achieve, nine states are collaborating on a common end-of-course test for Algebra 2. Thirty states are working together through Achieve to align their individual State high school graduation requirements with the expectations of colleges and universities for entering student proficiency in math and English and the expectations of employers for entering worker proficiency in math and English.

There is increased interest from Governors and chief State school officers in working with Achieve using this bottoms-up standards-setting approach to reach of common core of standards. I can envision this process moving forward over the course of the next decade, especially as states’ interest in bench-marking standards with the world’s top-performing countries increases. As a result, there is a path toward a common core of voluntary national standards in the majority, if not all, states, with some variation among states added to the core. From the vantage point of the business community, in a global economy, it doesn’t make sense for states to have different standards. We just don’t want to see federal action inadvertently get in the way of the real progress that is being made in the states today. And, yes, we have sent that happen before as my October testimony before the Subcommittee indicated.

Q2. Is there any entity on which to model the independent council that provides comprehensive coordination? How does this body acquire the respect of the classroom teacher and partnership of the local school district? Would this entity really be the first of its kind?

A2. Business Roundtable does not have a position on the National Science Board’s recommendation to establish a STEM education council but, as I testified before your Subcommittee, it is my personal view that establishing an independent coordinating body with no budget or oversight authority likely would not be effective. Your question about the need for buy-in on the part of stakeholders, particularly teachers and local school administrations, to ensure success goes to the heart of the matter. State P-16 and P-20 STEM councils are attempting to do this, with great variation in their effectiveness.

I can’t speak definitively as to whether the STEM education council, as proposed by the National Science Board, would be the first of its kind. I am not aware of any such prior entity but I cannot say for sure.

Q3. It seems that all of the witnesses agree that better STEM coordination is needed. Please share what you think a successful model for improved coordination in STEM would look like, and/or how a single body responsible for STEM coordination could be supported by all stakeholders.

A3. In my view, the greatest need for coordination is knowledge transfer about what is working and what is not working to improve STEM education across the U.S. Achieve and other organizations are in a position to facilitate voluntary coordination/communication among participating states. They have realized some success but progress is slow. The good news is that the attention focused on STEM education by Congress has had an impact. States and districts are looking for best practices. Perhaps the best federal role at this stage would be to support research on the different models to determine effectiveness as well as using technology to more rapidly advance best practices.