S. HRG. 111–1003

AMERICA WINS WHEN AMERICA COMPETES: BUILDING A HIGH-TECH WORKFORCE

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

MAY 6, 2010

Printed for the use of the Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PRINTING OFFICE

67–045 PDF WASHINGTON : 2011

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

JOHN D. ROCKEFELLER IV, West Virginia, *Chairman*

DANIEL K. INOUYE, Hawaii
JOHN F. KERRY, Massachusetts
BYRON L. DORGAN, North Dakota
BARBARA BOXER, California
BILL NELSON, Florida
MARIA CANTWELL, Washington
FRANK R. LAUTENBERG, New Jersey
MARK PRYOR, Arkansas
CLAIRE MCCASKILL, Missouri
AMY KLOBUCHAR, Minnesota
TOM UDALL, New Mexico
MARK WARNER, Virginia
MARK BEGICH, Alaska

KAY BAILEY HUTCHISON, Texas, *Ranking*
OLYMPIA J. SNOWE, Maine
JOHN ENSIGN, Nevada
JIM DEMINT, South Carolina
JOHN THUNE, South Dakota
ROGER F. WICKER, Mississippi
GEORGE S. LEMIEUX, Florida
JOHNNY ISAKSON, Georgia
DAVID VITTER, Louisiana
SAM BROWNBACK, Kansas
MIKE JOHANNS, Nebraska

ELLEN L. DONESKI, *Staff Director*
JAMES REID, *Deputy Staff Director*
BRUCE H. ANDREWS, *General Counsel*
ANN BEGEMAN, *Republican Staff Director*
BRIAN M. HENDRICKS, *Republican General Counsel*
NICK ROSSI, *Republican Chief Counsel*

CONTENTS

WITNESSES

APPENDIX

AMERICA WINS WHEN AMERICA COMPETES: BUILDING A HIGH-TECH WORKFORCE

THURSDAY, MAY 6, 2010

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:29 a.m. in room SR–253, Russell Senate Office Building, Hon. John D. Rockefeller IV, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM WEST VIRGINIA

The CHAIRMAN. Good morning. The hearing will come to order.

Earlier this year, as one Susan Naylor at the table knows, in Parkersburg, West Virginia, I spent one of the most wonderful 3 hours that I've ever spent. It was on a Sunday afternoon, I think, or Saturday afternoon.

Ms. NAYLOR. It was on a——

The CHAIRMAN. As I said, it was on a snow day and it wasn't on Saturday or Sunday.

[Laughter.]

The CHAIRMAN. And anyway, it was—you know, you seek these things, when you're in an office like mine. You never have the chance to sort of sit down and talk with people who are doing what you're worried about and what you care about.

And so, I went over to Parkersburg, and they had teachers there, including Susan Naylor, who teach math and science. But, in the STEM concept, that's 50 percent. And we spent 3 hours talking about, you know, what—how do you get to a child? How do you get to a youngster on any of these subjects—particularly, math and science? They're resistant to them. They're afraid of them. The word "science" is a scary name to some. And we just had this fascinating talk.

One of the teachers had been a coal miner, and she brought quite a disciplined aspect to it. But, it was just an extraordinary experience in learning about how science and math teachers deal with students and how they get them to pay attention and to learn and to feel very good about that.

Anyway, so we had that. We talked for hours. And it really gave me tremendous hope, that experience. Not just because I know those students are getting a great education from terrific teachers, but I also know that they're becoming, potentially, a huge investment in our future.

When the America COMPETES Act became law in 2007, we were making a commitment to the science, technology, engineering, and mathematics disciplines, *i.e.,* STEM. America's place as a global leader was apparently unhappy, in all of those areas. The Act established several new education programs at the National Science Foundation, the Department of Energy, Department of Education, and it boosted funding for something which I cared about a lot, a math-based program called the Robert Noyce Teacher Scholarship.

And I worked with Congressman Sherry Boehlert—who's not even here anymore in the House; he's a wonderful, absolutely wonderful person—on education, science and technology, back in 2002, to get this program enacted and provide scholarships for science, math, and engineering students to become K-through–12 math and science teachers.

Since it was signed into law, this program has supported—and I love this—the funding for about 7,700 teachers of those subjects, who will reach students in some of the highest-needs school districts across the country.

Programs like these are really long-term investments. They don't attract a lot of public attention, but they affect the way the public's going to be, 10, 15, 20, 30 years from now. They pay incredible dividends. A world-class STEM workforce is absolutely fundamental to us, in this century and the ones in front of us, from developing clean sources of energy that reduce our dependence on foreign oil, to discovering cures for diseases.

Projections from the Bureau of Labor Statistics indicate that over 80 percent of the fastest-growing occupations depend on knowledge of mathematics and science. The figure I read was 80 percent. That's huge. Does one learn a lesson from that, or does one just simply ingest that and go about the business of the day? I ingest it. I think we all do here.

But, the National Science Board reported this year that, although the United States continues to lead the world in science and engineering, other countries are closing the gap by increasing their own investments. And that they are doing for sure. And our position in the world in some of these areas is troubling.

With America COMPETES, we planted the seeds of something very powerful. But, we have to nurture the investment if we want to reap the results and the benefits. The authorizations in that legislation expire this year—probably one reason for this hearing, wouldn't you think?

And as we look toward reauthorization, we need to evaluate our progress. In March, the Committee heard from the heads of several government agencies who echoed the long-term value of these investments in math, science, engineering, and technology.

With today's hearing, I'm very excited to hear from the incredible people who are actually making good on STEM's great promise. I thank you all. Susan Naylor, who I promise not to talk about too much, here from Wood County, West Virginia, was among the teachers I spoke with that day. She works every day in the trenches. And she won a national award for her teaching. Also, Dr. Jim Gates, a Physics Professor at the University of Maryland who has his own STEM story and now inspires a new generation of scientists.

These are practitioners. They're doctors, in a sense. They're teachers and doctors. I mean, it's the same thing, you're trying to get people to care about taking care of themselves, learning, enlarging their futures. And we have a lot to learn from these folks at the witness table about what works on the ground and what does not.

I also want to welcome our other very impressive witnesses, and thank them for sharing their experiences today. Number one, David Zaslav, President of Discovery Communications. I mean, that's all you have to say. That's one of the television stations I still do watch. And Ioannis Miaoulis, who is President and Director of the Museum of Science. And it says here, "Science Boston," but I think it should be "Science in Boston."

Dr. MIAOULIS. It is "in Boston."

The CHAIRMAN. Yes, thank you. And also Founding Director of the National Center for Technological Literacy. And Tom Luce, CEO of the National Math and Science Initiative and former Assistant Secretary of Education for Planning, Evaluation, and Policy.

I hope all of you will speak about the importance of integrating our efforts; in other words, we must continue to support STEM disciplines at school—elementary, secondary, and beyond—but, we also absolutely have to be sure that our students are getting the same support at home, which is a much more complicated subject, and from the media, which is an even more complicated subject.

So, this is incredibly important. I'm really proud of what you do—an investment in our community and our country's future. That's what we all want to do, in one way or another.

[The prepared statement of Senator Rockefeller follows:]

PREPARED STATEMENT OF HON. JOHN D. ROCKEFELLER IV,
U.S. SENATOR FROM WEST VIRGINIA

Earlier this year, in Parkersburg, West Virginia, I met with a group of science and math teachers. We talked for hours about the work they do every day to inspire their students. They told me why they got into their fields and why they keep at it. We also discussed what it takes to push that button in each student, to give him or her the skills to thrive for a lifetime. It gave me tremendous hope. Not just because I know those students are getting a great education, but also because we're making a powerful investment in our Nation's future.

When the America COMPETES Act became law in 2007, we were making a commitment to STEM, the science, technology, engineering, and mathematics disciplines. America's place as a global leader in those areas was at risk and we could not afford to fall behind. The Act established several new education programs at the National Science Foundation, and Departments of Energy and Education, and it boosted funding for existing programs such as the Robert Noyce Teacher Scholarship.

I worked with Congressman Sherry Boehlert back in 2002 to get this program enacted and provide scholarships for science, math and engineering students to become K–12 math and science teachers. Since it was signed into law, this program has supported the funding for about 7,700 teachers who will reach students in some of the highest-need school districts across the country. Programs like these are long-term investments—and they pay incredible dividends. A world-class STEM workforce is fundamental to addressing the challenges of the 21st century—from developing clean sources of energy that reduce our dependence on foreign oil to discovering cures for diseases.

Projections from the Bureau of Labor Statistics indicate that over 80 percent of the fastest-growing occupations depend on knowledge of mathematics and science. The National Science Board reported this year that although the Unites States continues to lead the world in science and engineering—other countries are closing the gap by increasing their own investments in research, infrastructure, and education.

With America COMPETES we planted the seeds of something very powerful, but we have to nurture the investment if we want to reap its benefits. The authorizations in that legislation expire this year and, as we look toward reauthorization, we need to evaluate our progress.

In March, the Committee heard from the heads of several government agencies who echoed the long-term value of these investments. With today's hearing, I am excited to hear from the incredible people who are actually making good on STEM's great promise.

Susan Naylor here today from Wood County, West Virginia, was among those teachers I spoke with in Parkersburg. She works every day where the rubber meets the road, and I hope she will speak about the challenges of implementation. So will Dr. Jim Gates, a physics professor at the University of Maryland, who has his own STEM story and now inspires a new generation of scientists. These are practitioners and we have a lot to learn from them about what works and what does not.

I also want to welcome our other impressive witnesses and thank them for sharing their experiences today. David Zaslav, President and CEO of Discovery Communications; Dr. Ioannis Miaoulis President and Director of the Museum of Science Boston and Founding Director of the National Center for Technological Literacy; and Tom Luce, CEO of the National Math and Science Initiative and former Assistant Secretary of Education for Planning, Evaluation and Policy Development.

We have to work together to support STEM disciplines at school of course, but we also must make sure our students are getting the same support at home, in our communities, and from the media. This is incredibly important—it's an investment in our community and our country's future. And if we get it right, the rewards will be enormous.

And I now call upon my distinguished Co-Chair, Kay Bailey Hutchison.

STATEMENT OF HON. KAY BAILEY HUTCHISON,
U.S. SENATOR FROM TEXAS

Senator HUTCHISON. Thank you, Mr. Chairman.

I'm very pleased to be here. I really appreciate your calling this hearing, because the reauthorization of the America COMPETES Act is very important for our country. And I'm very appreciative that you, Mr. Chairman, prioritize it, as I certainly do.

I do want to thank all the witnesses, because each of you are contributing to our goal of increasing the number of our students who go into the STEM courses and are prepared for the STEM courses.

I especially appreciate that my request was answered, that Tom Luce would be one of our witnesses. He is, as you said, the CEO of the National Math and Science Initiative, and former Assistant Secretary of Education. But, he is doing what we're talking about, and also fostering an innovative program, that was started at the University of Texas, called "UTeach."

Science, technology, engineering, and math, or STEM, education plays an essential role in fostering the further development of our innovation-based economy. But, several recent studies caution that a danger exists that Americans may not know enough about STEM fields to significantly contribute to, or benefit from, the knowledge-based society that is taking place.

In my home State of Texas, 41 percent of the high school graduates are ready for college-level math; 24 percent are ready for college-level science; furthermore, only 2 percent of all U.S. 9th-grade boys, and 1 percent of girls, will go on to attain an undergraduate science or engineering degree. In contrast to these troubling numbers, Mr. Chairman, 42 percent of all college undergraduates in China earn science or engineering degrees.

As nations like China and India invest strategically in STEM education for their citizens, the United States must assess whether its education system can meet the demands of the 21st century. If we fail to address these challenges, we risk compromising the development of the next generation of American scientists, engineers, and mathematicians.

I believe that a solid foundation for a scientifically literate workforce begins with developing outstanding K–12 teachers in science and mathematics. Unfortunately, today there is a shortage of highly qualified K–12 teachers that many of our Nation's school districts are hiring.

Statistics also demonstrate that a large percentage of middle and high school mathematics and science teachers are teaching outside their own primary fields of study. While a United States high school student has a 70-percent likelihood of being taught English by a teacher with a degree in English, that same high school student has only a 40-percent chance of studying chemistry with a teacher who has majored in chemistry. These statistics are not acceptable.

I want to ask Mr. Luce to expand on this, but I am pleased that Texas is leading the way, with the UTeach program. Beginning in 1997, this program was started, and has been mentioned in several studies, including Rising Above the Gathering Storm, which was the impetus for the America COMPETES Act.

I plan to introduce legislation soon that will create a grant program to allow colleges and universities to adopt the UTeach Program to recruit and prepare students who major in science, technology, engineering, or math to become certified as elementary and secondary schoolteachers through electives. That's what the UTeach Program is. Mr. Luce's organization does this through private funding, and has done a phenomenal job. I just want to spread it out throughout our country.

I will ask Mr. Luce some of the questions about how many of the teachers who get this degree, an engineering or science degree with a teacher-elective certification, how many of them stay in teaching. It's a great statistic. And I think that it is, according to the Rising Above the Gathering Storm, the best incentive that we can give our young people in secondary school, offering the opportunity to take these courses from a teacher that majored in them and loves the course and will imbue that enthusiasm to the student.

So, Mr. Chairman, I'm excited about reauthorization, and I look forward to working with you for a wonderful bill that will be bipartisan, just like the first one, America COMPETES, was.

Thank you.

[The prepared statement of Senator Hutchison follows:]

PREPARED STATEMENT OF HON. KAY BAILEY HUTCHISON, U.S. SENATOR FROM TEXAS

Mr. Chairman, thank you for holding this hearing today. I want to welcome our witnesses, each of whom plays an important role in encouraging young minds to pursue coursework and experiences that will position them to be the best minds available to work on science, engineering, math, and technology in the future.

Science and technology are at the core of America's ability to compete in an increasingly globalized economy and to solving many of the challenges we face as a nation in energy independence, biotechnology, and healthcare.

Science, Technology, Engineering, and Mathematics education, or STEM education, plays an essential role in fostering further development of the 21st Century's innovation-based economy. Several recent studies caution, however, that a danger exists that Americans may not know enough about the STEM fields to significantly contribute to, or benefit fully from, the knowledge-based society that is taking shape around us.

In my home state of Texas, only 41 percent of the high school graduates are ready for college-level math (algebra), and only 24 percent are ready for college-level science (biology). Furthermore, only 2 percent of all U.S. 9th-grade boys and 1 percent of girls will go on to attain an undergraduate science or engineering degree.

In contrast to these troubling numbers Mr. Chairman, 42 percent of all college undergraduates in China earn science or engineering degrees.

As nations like China and India invest strategically in STEM education for their citizens, the United States must assess whether its education system can meet the demands of the 21st Century. If we fail to address these challenges we risk compromising the development of the next generation of American scientists, technologists, engineers, and mathematicians, making it more difficult to address persistent national problems.

I believe that a solid foundation for a scientifically literate workforce begins with developing outstanding K–12 teachers in science and mathematics. Unfortunately, today there is such a shortage of highly qualified K–12 teachers that many of the Nation's school districts have hired uncertified or under qualified teachers.

Statistics also demonstrate that a large percentage of middle and high school mathematics and science teachers are teaching outside their own primary fields of study.

While a United States high school student has a 70 percent likelihood of being taught English by a teacher with a degree in English, that high school student has only about a 40 percent chance of studying chemistry with a teacher who was a chemistry major.

Those statistics are unacceptable and they are also unnecessary. We can and must do better and I believe we should use this reauthorization process to encourage programs that increase the number of teachers in STEM fields certified to teach in those areas.

I am pleased that Texas has been a leader in this area and has a model program that combats this problem by effectively combining undergraduate degrees in the STEM fields with teacher certification.

Beginning in 1997, the UTeach program has become the national benchmark for teaching excellence and has been mentioned in several high profile reports including the National Academies' "Rising above the Gathering Storm" report.

I plan to introduce legislation soon that will create a grant program to allow colleges and universities to adopt the UTeach program to recruit and prepare students who major in science, technology, engineering, or mathematics to become certified as elementary and secondary school teachers. I hope as we move forward this can be included in the America COMPETES Act reauthorization.

In addition to increasing the number of certified teachers in STEM fields, I believe that improving the K–12 curricula in the STEM fields is essential because domestic and world economies increasingly depend on these areas of knowledge. Unfortunately, primary and secondary schools frequently fail to produce enough students with the interest, motivation, knowledge, and skills they will need to succeed in the 21st Century's global economy.

I think we can make America even more competitive and innovative than it is today. We can and we must.

Thank you again, Mr. Chairman. I look forward to hearing from our witnesses.

The CHAIRMAN. Thank you very much, Senator Hutchison.

Let me—David Zaslav, can we start with you?

And incidentally, in the Senate, no Senator ever, ever talks for more than 5 minutes.

[Laughter.]

The CHAIRMAN. And therefore, we kind of apply the same rules to you.

STATEMENT OF DAVID ZASLAV, PRESIDENT AND CEO, DISCOVERY COMMUNICATIONS

Mr. ZASLAV. OK. Thank you, Chairman Rockefeller, Ranking Member Hutchison, and distinguished members of the Committee.

My name is David Zaslav, President and CEO of Discover Communications, the world's number-one nonfiction media company.

When John Hendricks first created our company, he named it the "Cable Education Network," with a mission to empower people to explore their world and satisfy their curiosity. Of course, the name later changed to "Discovery." But, education has remained in our DNA ever since.

Today, Discovery has 13 U.S. networks and more than 120 networks around the world, and our Discovery Education division provides digital content to more than 1 million U.S. teachers and 35 million students, all aligned to State education standards, making Discovery Education the leading provider of digital media to America's classrooms.

I'm honored to be here today to talk about how Discovery can join with you, the Obama Administration, and private industry to help inspire our children to love science.

As you know, Mr. Chairman, America faces a serious challenge. In an age where innovation and knowledge are the drivers of economic growth, too few of our kids are passionate about STEM. If we don't ignite that passion, this country will simply not be able to meet its most pressing challenges.

Mr. Chairman, just a little over a year ago, you visited the Mount View School, in Welch, West Virginia, to celebrate a phenomenal teacher, Ed Evans. Mr. Evans was named America's top science teacher in our Discovery Education 3M Young Scientist Challenge, which, for 12 years, has been encouraging the exploration of science among America's middle school students. You got to be a student in his class that day, even joining the kids to dissect owl pellets. You saw firsthand how enthralled the kids were with the lesson.

What if all science classes were as engaged as Mr. Evans' class? What if every computer, iPod, and TV was transformed into an exciting new place to learn about science? Could we unleash the next great generation of scientific advancement? At Discovery, we believe we can and we believe we must. So, we commend Congress for working to reauthorize the 2007 America COMPETES Act. We're also excited to be a part of President Obama's Educate to Innovate initiative.

Today's students live in the digital world. They e-mail, text, tweet, and chat. They carry video clips in their hands. It's a whole new world. At Discovery, we are focused on using digital tools to make science and math curricula more engaging.

Imagine a typical science class studying volcanoes. Through Discovery Education Science, our web-based science curriculum service, an educator can download a 3-minute video clip and accompanying simulations that take her students beyond the four walls of their classroom.

We're also partnering with the Siemens Foundation on the Siemens STEM Academy, a unique national initiative offering free hands-on and web-based STEM professional-development re-

sources. These are just two examples of our classroom-based initiatives.

But, what about the hours when kids aren't in school? The truth is that when they're not in class, and sometimes even when they are, kids spend many of their waking hours engaging in media. That's why Discovery launched the "Be the Future Campaign," a multimedia, multiyear, nationwide initiative that includes a 6-day-a-week commercial-free kids block called HEAD RUSH. It will launch in August on our Science Channel, which is the only 24-hour-a-day channel devoted entirely to the amazing world of science. HEAD RUSH will feature MythBusters, the number-one show on Discovery Channel for 12- to 17-year-olds in the U.S. It will be hosted by MythBuster Kari Byron. We know girls often lose interest in math and science during their middle school years, and we believe Kari is a great role model who will inspire more girls and boys to fall in love with math and science.

Here's a quick snapshot of HEAD RUSH.

Let's roll the tape.

[Video presentation.]

Mr. ZASLAV. To ensure that this content is accessible to as many kids as possible, we're allowing distributors across the country who want to make the Science Channel more widely available to do so at no additional cost to distributors.

Discovery is ready, able, and eager to be a partner with the Federal Government in this great endeavor of supporting STEM.

And I want to thank the Committee for the opportunity to speak. And I request an extended version of my testimony be entered into the record. And I look forward to answering any of your questions.

Thanks for having me.

[The prepared statement of Mr. Zaslav follows:]

PREPARED STATEMENT OF DAVID ZASLAV, PRESIDENT AND CEO, DISCOVERY COMMUNICATIONS

I. Introduction

Thank you Chairman Rockefeller, Ranking Member Hutchison, and distinguished members of the Committee for convening this important hearing. My name is David Zaslav and I am President and CEO of Discovery Communications, home to Discovery Channel, Science Channel, Animal Planet and Planet Green among other great brands. We are the world's number one nonfiction media company, with 13 television networks in the U.S. and over 120 networks in more than 180 countries. In addition, Discovery Education, our education division, provides digital content to over half the schools in the nation, making it the leading provider of digital media to America's classrooms. Our mission, as set forth by our founder John Hendricks nearly 25 years ago to this very day, is to empower people to explore their world and satisfy their curiosity with high-quality nonfiction content that entertains, engages and enlightens.

When John first created our company, he named it the Cable Education Network. He soon decided Discovery Channel was a more descriptive way to communicate the ambition of what the channel could be. And Education has remained in the DNA of Discovery Communications ever since.

Our organization's very first viewer phone call was from an educator. It was 1985, the year our visionary Founder and Chairman John Hendricks launched the Discovery Channel, and we had just aired our first program, "Iceberg Alley." As soon as it was over, a teacher called to ask for permission to show it to her class the very next day. We agreed!

So we've had a long-standing commitment to education and it's that commitment I'm honored to discuss with you today.

As you know Mr. Chairman, America faces a serious challenge. In an age when innovation and knowledge are the drivers of economic growth, too few of our kids

are passionate about—or versed in—science, technology, engineering, and math (STEM).

I'm honored to be here today to talk about how Discovery can join with you, the Obama Administration and private industry to help inspire our children to love science!

If we don't ignite that passion, this country will simply not be able to meet our most pressing challenges—from energy security to the environment to urban development.

Mr. Chairman, just a little over a year ago, you visited the Mount View School in Welch, West Virginia to celebrate a phenomenal teacher, Ed Evans. Mr. Evans won the title of "America's Top Science Teacher" in our Discovery Education—3M Young Scientist Challenge, which for 12 years has been encouraging the exploration of science among America's middle school students.

You got to be a student in his class that day, even joining the kids to dissect owl pellets. The kids were so enthralled with the lesson—which Mr. Evans brought to life with our online science education service—that they barely seemed aware of the cameramen in the room. And, Mr. Chairman, however you feel about owl pellets, I would guess that you were moved by your experience.

II. Discovery's Mission

Mr. Evans and his class embody the heart of our mission.

We believe that all girls and boys can fall in love with science. Kids' innate curiosity, limitless sense of possibility, and wide-eyed fascination with all creatures great and small make them natural explorers.

We believe that we have an obligation to capitalize on this sense of wonder, to encourage kids' desire to investigate the world, and to help them understand all they see.

We believe this is critical—because developing and honing their curiosity, critical thinking, and reasoning skills will serve them in whatever path they choose. And teaching children how to blend those tools with a healthy imagination will not only help them live rich and fulfilling lives—it will help our country stay on the cutting edge of exploration and innovation.

What if all science classes were as engaged as Mr. Evans' class?

What if every kid in America believed that geologists were the real rock stars?

What if kids obsessed about physics the way they do about Facebook?

What if every computer, iPod, and TV was transformed into an exciting new place to learn about science?

Could we unleash the next great generation of scientific advancement?

At Discovery, we believe we can. And we believe we must.

III. Global Competition

In 1983, just 2 years before Discovery Channel's launch, the National Commission on Excellence in Education released the seminal report, "A Nation at Risk." It documented a decline in American educational achievement, warning that, "Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world."[1]

Sadly, over two decades later, very little has changed. According to the National Center for Education Statistics, almost one-fifth of fourth-graders and almost one-third of eighth-graders scored below the basic level of achievement on national assessments (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP) 2009). The United States ranks 21st of 30 OECD countries in scientific literacy, and U.S. students scored below the OECD average in math literacy (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, *Highlights from PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context*).

Even as the promise of scientific innovation has exponentially increased, American students have lost interest in science, technology, engineering, and math. Between 1960 and 2001, the number of U.S. bachelor or graduate degrees awarded in engineering, math, or physical sciences had dropped by 50 percent, from one out of every six to one out of every ten of all degrees awarded in our country. (National Science Foundation, Science and Engineering Indicators, 2004.)

This is happening at a time when we badly need STEM professionals. Over the next decade, baby boomer retirements will cut the science and engineering workforce in half. Meanwhile, according to the National Science Foundation, jobs in

[1] U.S. Department of Education. National Commission on Excellence in Education. *A Nation at Risk*. April 1983. *http://www2.ed.gov/pubs/NatAtRisk/risk.html*.

science and engineering will increase three times faster than jobs in every other sector. (National Science Foundation, Science and Engineering Indicators, 2004.)

If the economic crisis has taught us anything, it's that innovation, technology, and entrepreneurship are the wave of the future.

But without a strong STEM work force, future generations will be ill equipped to solve tomorrow's scientific challenges, threatening America's global competitiveness.

Countries like India, China, and South Korea relentlessly focus on math and science, and produce far more technical experts in these fields every year than we do. They understand that the key to the 21st Century economy lies in these critical areas. Whichever nation can build the next electric car or cure cancer or develop new renewable sources of energy will thrive in decades to come.

But right now, science and math aren't nearly cool enough for America's kids.

The 2005 National Academies of Science study, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" detailed this challenge. It's telling that the report's first recommendation is to dramatically improve STEM education.

We commend Congress for responding to the study by enacting the 2007 America COMPETES Act, which contains crucial STEM provisions like scholarships to recruit and develop new STEM teachers. We look forward to its reauthorization.

We also commend President Obama's call to action to raise student achievement in math and science. We are proud to be a partner in the Administration's "Educate to Innovate" initiative, which spurs partnerships across the private, public and nonprofit sectors in an effort to restore America's place as a global leader of scientific achievement and innovation. We are encouraged by the President's strong commitment and by the Federal Government's serious investment in STEM education. And we're using our expertise and resources to innovate how we deliver STEM education, particularly science education, to our youngsters.

IV. Fulfilling the Mission

When the Discovery Channel first went on the air 25 years ago, few families owned personal computers, Microsoft had just released its inaugural Windows 1.0, and the American public was just introduced to the latest technology called the 'compact disc.'

You may be hard pressed to find a 13-year-old who owns a CD these days.

Today's students live in the digital world. They are astonishingly familiar with digital media and technology, and they can interact with information—and process it—at rapid speeds. They multitask, engage across different media, and communicate with each other and a diverse array of content instantly and constantly. They e-mail, text, tweet, and chat. They carry video clips in their hands.

It's a whole new world. And it's a whole new student—which means fulfilling the mission of delivering great STEM content that engages, excites, and educates today's kids looks very different from what it looked like in 1985.

That's why Discovery launched the "Be the Future" campaign, a multimedia, multi-year, nationwide initiative—aimed inside and outside the classroom—that celebrates and teaches how science shapes the world.

We made a decision nearly 5 years ago to form Discovery Education. Today, Discovery Education is on the leading edge of harnessing technology to create innovative digital services that make science and math curricula more engaging. To make sure these new tools and resources are maximized to their highest potential, we are also providing effective professional development for teachers.

Today, 1 million educators, and more than half of U.S. schools, use Discovery Education's digital services. There are more than 125,000 members in our Discovery Educator Network, the global professional learning community supported by Discovery Education and offering educators free professional development and networking opportunities. As a result, our content reaches 35 million students.

For example, Discovery Education *streaming*, offers teachers and students more than 150,000 digital learning objects, including videos, interactives, images, articles and more, that integrate seamlessly into any curriculum. Aligned to state standards and assessments and searchable by keyword, content area and grade level, the rich video content and other digital assets from Discovery Education engage today's students in learning.

And we've seen evidence that increased Discovery Education *streaming* use is associated with higher achievement scores in math and reading. It makes sense—today's kids are digital learners.

Today's science teacher can do more than just lecture about volcanoes. Through Discovery Education Science, our web-based digital curriculum service correlated to state science standards and organized around an inquiry-based framework, a science

teacher can download a 3-minute video clip, as well as accompanying multimedia simulations, that take her students not only to a volcano, but around the world, so that students can witness the impact volcanoes have on our environment.

But we're ready to do more. We want to take what we've learned, strengthen our programming, and broaden our impact. That's where "Be the Future" comes in.

"Be the Future" includes more classroom-based initiatives like STEM Connect. A curriculum-based and career development resource launched in November 2009, STEM Connect is designed to fuel teacher and classroom engagement by helping students link science, technology, engineering and mathematics to the real world. Through a collection of rich media, educational content, career exploration tools, interactives, and hands-on activities, STEM Connect makes science concepts come alive.

Instead of just reading about what makes a car aerodynamic or why some cars are more fuel efficient than others, a 9th grade science class can go to our website and apply these concepts by building a virtual vehicle.

We're also using our resources to help teachers be even more effective with their students. We've partnered with the Siemens Foundation to create the Siemens STEM Academy, a national initiative offering free hands-on and web-based STEM professional development resources and opportunities for educators that boost science, technology, engineering and math learning in the classroom.

A major component of the Siemens STEM Academy is a week-long, immersive Institute planned for this summer in Washington, D.C. During this Institute, educators from around the Nation will learn from the top minds in the STEM field, take field trips to local institutions to see the real world applications of STEM subject matter, and network and collaborate with peers from across the U.S. We hope that the reauthorization of America COMPETES will enhance these sorts of practical professional development opportunities for teachers.

In addition, Discovery will continue to host its popular science competitions, like the Discovery Education-3M Young Scientist Challenge, which allows excellent science students to demonstrate their talent in fun ways.

It's important to note that the past two winners of this contest have been young women. We know that girls often lose interest in science and math in the middle school years. So we're excited about the possibility of competitions like this to engage girls and minorities in the subject of science, giving them a new forum to shine in a discipline where they are vastly, and needlessly, underrepresented.

These are just a few examples of our classroom-based initiatives. And Discovery will continue to develop and deliver innovative solutions for the classroom.

But what about the hours when kids aren't in school?

The truth is that when they're not in class—and sometimes even when they are—they spend much of their time engaging in social media. According to a recent Kaiser Family Foundation survey of 2,000 people ages 8 to 18, today's kids spend more than 53 hours a week with digital media. This constant interaction with media equates to a full-time job of learning through "untraditional" means (Kaiser Family Foundation, Generation M2: Media in the Lives of 8–18 Year Olds, 2010).

So outside of the classroom, "Be the Future" is using that media to connect kids with science even after the school bell rings.

We call this "Science 360"—reaching kids where they are, from every possible angle, with every imaginable tool.

That is why I am proud that Discovery Communications is the only media company with a 24-hour channel devoted entirely to all facets of the amazing world of science, and Science Channel lives across many platforms. In addition to working with some of the foremost science minds in the world, we are working with the best award-winning storytellers and directors in Hollywood, like Steven Spielberg, James Cameron, Morgan Freeman and Will Smith. Even SIMS creator Will Wright is bringing his gaming genius to the network. They are igniting their love of science to inspire others to imagine what might be possible.

This commitment to bringing the wondrous world of science to our children is illustrated in the Science Channel's 6-day-a-week commercial-free kids block, called HEAD RUSH, which will launch in August. And because we want to ensure that this content is available to as many kids as possible, we're offering it to distributors at no additional cost.

We're thrilled that some distributors have already taken advantage of this opportunity for their subscribers. Direct TV has already agreed to make the Science Channel more widely available, and Cablevision—which has a strong interest in science literacy and other educational initiatives—has made the service available to the majority of their subscribers. Our hope is that as more of our affiliate partners follow suit, and as more kids get into HEAD RUSH, we'll be able to create even more new content, with some of the most prominent directors and storytellers in

Hollywood and the music industry, to feed these hungry minds. If HEAD RUSH were accessible to a broader base of kids—and not simply those in the more affluent homes that have broad digital cable packages—we would be able to supercharge the block with even more exciting content.

HEAD RUSH will include one of our most popular programs, MythBusters, whose team tests hypotheses involving everything from whether it's possible to train a fish to whether a person can be sucked down by killer quicksand. Called "the best science show on television" by the New York Times, it's the #1 show on Discovery Channel for 12–17 year olds.

And because we know that girls often lose interest in math and science during their middle school years, we chose Kari Byron, a self-described "artist, science chick, and working mom," and an integral part of the MythBusters team, as the host of HEAD RUSH. Kari is a great role model—and we hope she'll inspire more girls—and boys—to fall in love with math and science. We hear regularly from educators that they love MythBusters and how it helps demystify science and make it relevant and engaging to young people.

In addition to the MythBusters episodes, we are creating original short-form content to encourage and excite kids. In HEAD RUSH, Kari will be doing hands-on science projects and playing interactive games with kids across the country. It will take the form of fun and exciting question and answer segments challenging students to test their knowledge with STEM-based content. We will also feature high-profile Discovery Communications talent who serve to illustrate how the "coolest careers" use STEM every day: Architect Danny Forester from Science Channel's hit series "Build it Bigger" shows how math informs the engineering work on a construction site; the intrepid team on Discovery's "Storm Chasers" who rely on advanced technology to help them hunt down tornadoes present a question about the physics of the natural world. The idea is to create dynamic and entertaining scenarios that illustrate how STEM is an integral part of everyday life. In addition, we will cover kids creating their own science and feature them as they unfold the exciting and amazing world in their own experiments. And to round off our commitment, we will create an original STEM PSA that will run across all of our networks in the United States.

As part of "Be the Future," John Hendricks, Discovery's visionary founder, is spearheading an exciting new series called "Curiosity: The Questions of Our Life." In partnership with some of the leading universities across the county, it will tackle the fundamental questions and underlying mysteries of everything from space to medicine to archaeology to the human mind. It is a five-year, 60-episode endeavor that will begin airing on Discovery Channel and Science Channel next year.

We're also launching "Energy: Powering the Future," a forward-looking series that explores what the world will look like in 2050 from a scientific perspective in a cool and engaging way. And we're linking the program to Facebook and Twitter, giving kids, parents and teachers a way to join the conversation and connect with real-life scientists and experts.

Our vision is that the 9th graders who build their virtual car in class might come home to an episode of "Energy" about what cars will be like in the future. And then perhaps they'll log onto their Twitter account and start following news about the latest science breakthroughs.

In addition, Discovery Education is working with cable operators outside the classroom to bring our rich, educational programming to as many families as possible. In partnership with Comcast of Indianapolis, families now have access to compelling educational VOD content through Discovery Education on Demand, by Comcast.

We think it's possible. Take it from a recent wall posting on the Science Channel Facebook page: "The Science Channel rules and now I'm all excited about nanotechnology, Moore's law, and futurism and time-space relativity!"

This is what Science 360 is all about.

V. Conclusion

Mr. Chairman, if we're serious about improving STEM education, then we have to acknowledge and accept that today's students live in a different world than the one we have known. We need to begin moving beyond traditional educational materials like the static textbook and toward engaging classrooms and living rooms that are alive with compelling visuals and storytelling. Most of all, we have to respect that as children have evolved, their way of learning has evolved—and it's up to us to make sure that our teaching evolves, too.

America needs a world-class STEM workforce to tackle the challenges of the next generation, from energy security to stemming infectious disease.

And America needs a generation of young people who are curious about the vast unknown universe, who are excited about discovering its wonders, who are inspired to push the limits of what's possible.

Discovery believes that we have an obligation to help our youngsters cultivate that curiosity, that excitement, that sense of wonder. We're ready, able, and eager to be a partner with the Federal Government in expanding and innovating how we teach science—and we are convinced the potential for what our children can achieve is limitless.

Thank you very much.

The CHAIRMAN. All statements will be entered into the record automatically.

Thank you very much.

Ms. Naylor.

STATEMENT OF MS. SUSAN NAYLOR, NBCT, PAEMST, INSTRUCTIONAL COACH, WOOD COUNTY SCHOOLS, PARKERSBURG, WEST VIRGINIA

The CHAIRMAN. Pull the mike up, too.

Ms. NAYLOR.—booster chair.

Senator Rockefeller referred to the Presidential——

Do I get my 5 minutes back?

I was here in Washington, D.C., in January with all of the Nation's Presidential award-winners. And we had an opportunity to compare notes with each other. And the priority concern, unanimously, among all of us was professional development for teachers.

When Senator Rockefeller was in Parkersburg, one thing that I mentioned to him is that it seems like most of the teachers in the work force, a lot of them, are my age; we grew up in the 1950s and the 1960s. And we were led to believe, whether consciously or directly, that science and math fields were not for girls. And so, we became accustomed to thinking that we couldn't do it, that it was too hard.

Those same teachers are in the classrooms today, and they went through college in the 1970s, and they did not get the content knowledge that they need to feel confident to help lead children in the fields of science and mathematics.

Teachers need onsite embedded professional development. They are very busy with their families, running to soccer games and church meetings. They can no longer pack up a suitcase and go to a big metropolitan center for 3 days of training and then go back to their classrooms and pick up their lives and have no support or nothing to sustain what they learned. They need to have professional development delivered to them in their own classrooms, and they need to have a support network that will help maintain that implementation.

The whole Nation is in a transformation from traditional teaching, which most us—most of the teachers in the teaching field grew up as students of traditional teaching, where the teacher stands in front and lectures, to more inquiry-based investigative experiential science and math activities, which—research shows children learn much deeper content when they experience science and math this way.

When Senator Rockefeller was visiting with us, he mentioned about the spark. And what do you do about that spark of curiosity in young children? I can tell you that, as a veteran first-grade

teacher for 30 years, 6-year-olds come to school with that spark. I don't know what happens by the time they get to middle school, except that I think the teachers that are intimidated by content end up falling back on the traditional strategies and materials that they are comfortable with, even though they are not as effective. And some of that spark fails to get ignited into flame. And then those children become just as intimidated by math and science as I was.

I never would have imagined, in high school, that I would have been receiving a Presidential award for excellence in mathematics. I'm sure my high school teachers would never have believed that, either.

Another thing that teachers campaign for is new certification areas. We would like to—because many of us do not have the deep content knowledge that we need, not only in science and math, but also in understanding technology and how to integrate it into classrooms, we would like to see certification fields that endorse those things, that prepare teachers, that can be support in the classrooms for teachers as they do this. We'd like to see incentives for veteran teachers, like myself, to go in and retrain in these certification areas and bring that expertise into classrooms.

One thing that concerns me is some of the secondary teachers that I talked to talked about scholarships for STEM students. I'm a little bit concerned about scholarships that focus on GPA, because if children are protecting their GPA so that they are eligible for scholarships, they are not going to attempt these harder courses.

I'm also a little bit concerned, as Senator Hutchison was referring to—the time that is given to reading in elementary schools is protected. In West Virginia, it's 90 minutes a day, uninterrupted. But, math only gets 60 minutes. Recently, I heard a teacher suggest that we take science off our report cards. If we don't assess science, it's not going to get taught. And that is a very scary thing to me. A lot of the money for materials and teachers goes into reading that doesn't go into math and science.

I am very interested in seeing more hands-on materials. Senator Rockefeller mentioned about parents getting involved. There are a lot of teachers that are willing to do parent training, to have family science nights in the evenings. But, they need the materials and the training to feel confident to be able to do that.

I can't tell you how many parent-teacher conferences I've been in where a parent says—if a child's not doing well in math and science—they will say, "Well, they get that honestly. I didn't do very well in math and science, either." But, they never say that about reading. We need to help parents feel confident about helping their kids with math and science.

Thank you very much.

And I hope that I am the first of many teachers that you will reach out to for their expertise and their experience, because the decisions that you all are making are going to affect what we can do for children in the classrooms.

[The prepared statement of Ms. Naylor follows:]

PREPARED STATEMENT OF MS. SUSAN NAYLOR, NBCT, PAEMST,
INSTRUCTIONAL COACH, WOOD COUNTY SCHOOLS, PARKERSBURG, WEST VIRGINIA

Chairman Rockefeller, Ranking Member Hutchinson and members of the Committee, thank you for this opportunity to bring a teacher voice to your work.

During the past 10 years, I have served on a variety of initiatives that have shaped the evolving face of mathematics education in West Virginia. I have seen our instructional standards written and re-written during that time, in a continued effort to improve the rigor and relevance of the curriculum we provide our students. Focus on relevant assessment and technology integration has also been emphasized. STEM education programs that have provided the funds for research and development in these areas, like the Re-invent initiative, have been extremely effective.

As a veteran teacher, I have several concerns for your consideration as you make decisions that will impact the future of science, mathematics and technology instruction in America's classrooms.

Earlier this year, I visited Washington, along with the other Presidential Awardees in Mathematics and Science from across the Nation. While here, we were provided opportunities to talk with each other. The unanimous and highest priority concern of the entire group was professional development for teachers. There is currently a difficult transformation taking place in classrooms as "traditional" teachers face the unavoidable transition to the more "inquiry" based teaching philosophies and materials needed to support students in reaching higher standards. Research indicates that children acquire and retain deeper conceptual understanding of both mathematics and science through experiential problem solving. However, many teachers have not received sufficient professional development to feel confident using these new strategies and materials, so they fall back on what is familiar, even though not as effective. Teachers also need deeper understanding of their own content areas in order to effectively challenge and remediate students on different levels. I am very encouraged by the new Common Core standards that will provide common benchmarks nationwide. They will foster collaborative professional development initiatives that will not only provide consistency between states, but hopefully save money as we cease trying to reinvent the same wheel 50 times.

Teachers would like to see new certifications available, like elementary mathematics specialists and interventionists whose specialized content knowledge would support classroom teachers. Incentives for teachers who choose teaching certifications in the STEM fields would help recruiting, and of course, fair and equitable salaries would help encourage highly qualified teachers to stay in education instead of seeking higher salaries in other fields. Another consideration would be a system of recognizing and rewarding teachers who do integrate STEM initiatives in their classroom

More scholarship incentives available in STEM fields could make a powerful impact on student career choices. However, scholarships that focus too much on a student's GPA encourage them to take easier classes to protect that GPA, instead of taking on the challenge of more difficult classes. There is also the issue of "teaching to mastery" as opposed to the traditional "63 percent as passing" to consider. College course offerings in the STEM fields would be more accessible to students if they were available on community campuses and would provide a more seamless transition from high school to college level courses.

Elementary teachers are concerned about the discrepancy between the emphasis placed on Reading/Language Arts and that placed on Mathematics and Science. In many states, the amount of instructional time as well as the amount of money invested in materials and intervention programs is much higher for reading. I recently learned of a proposal to remove Science from elementary report cards. That worries me; what gets assessed is what gets taught. If 80 percent of the careers of the future are rooted in science and mathematics, these subjects should be receiving more emphasis, not less.

Money is another issue. The cost of hands-on inquiry science materials, like SIMPLE (Science Inquiry Modules and Problem-based Learning Experiences) kits and Nova labs is high, not to mention the refurbishment of consumable materials for them, but they are the best vehicle for teaching deep conceptual understanding. The northern panhandle area of West Virginia has seen improvement in science scores since the implementation of these materials. At the same time, West Liberty University, located in the same area, has seen an increase in students pursuing degrees in science!

West Virginia has been proud of the technology integration in our classrooms, but sustaining it is becoming a losing battle. In this area as well, teachers have not received sufficient professional development to feel confident integrating technology into their instruction. Technology integration specialists who could support class-

room teachers are too few and far between, some even being eliminated as funds are cut. At Parkersburg High School, (1,750 students), there are nearly 700 computers, but not one full time tech to service them. It is not unusual for a work request for computer repair/maintenance to take 90 days for response. In my school system, there are approximately 4000 student computers, and at a replacement rate of 10–15 percent each year, these machines need to stay in service for 8–10 years, but many of them were refurbished to begin with. All classrooms need interactive whiteboards to facilitate and engage students in collaborative learning and teachers need support in incorporating them.

Many teachers feel that more direct contact between students and the community businesses that will need graduates in the STEM fields would make career choices in these fields more likely. Shadowing programs, visiting experts in classrooms, and partnering projects are avenues for cultivating these relationships.

A second major concern expressed by the Presidential Awardees was the need for teachers to be given a voice in decisionmaking beyond the local level of their own school systems. Thank-you for giving me that opportunity today and hopefully other teachers will take my place here as you reach out for the experience and expertise they can bring to your work.

The CHAIRMAN. Thank you very, very much.

Dr. Gates.

STATEMENT OF DR. S. JAMES GATES, JR., JOHN S. TOLL PROFESSOR OF PHYSICS AND DIRECTOR, CENTER FOR STRING & PARTICLE THEORY, PHYSICS DEPARTMENT, UNIVERSITY OF MARYLAND

Dr. GATES. Good morning, Chairman Rockefeller——

The CHAIRMAN. You've got your—push your button there. There we go. OK.

Dr. GATES. Good morning, Chairman Rockefeller, Ranking Member Hutchison, and other distinguished members of the Committee.

I also want to greet my fellow witnesses and all who work for the security of the brightest possible future for our Nation.

Thank you for inviting me to testify on the subject of America Wins When America COMPETES.

I'm Jim Gates, the John S. Toll Professor of Physics at the University of Maryland and also the head of a research center there in something called "string theory."

The Committee's letter asked me to address four points: my own STEM story, ways to improve diversity in STEM fields, ideas to produce more qualified STEM teachers, and a perspective and recommendations on national STEM programs.

I emphasize my comments and perspectives will be personal ones. I am not speaking on behalf of any organization nor group with which I am affiliated.

My own STEM story begins with my father—my grandfather, Joseph, a poor, but land-owning farmer in Alabama. Though Joseph could neither read——

[Brief audio interruption.]

The CHAIRMAN. It was—it's the voice of God.

[Laughter.]

Dr. GATES. What do I do about my time?

[Laughter.]

The CHAIRMAN. You go right ahead. Go right ahead, sir.

Dr. GATES. Thank you.

Though Joseph could neither read nor write, he was good at ciphering, *i.e.,* arithmetic, and was fond of saying, "People don't mind being around people who know how to work hard." Their second

son, Sylvester James Gates, Sr., was my father. In 1941, my dad entered the U.S. Army as a 128-pound, 17-year-old kid, and he went to the second World War, and served 13 months in the famous Red Ball Express.

Near the Battle of the Bulge Memorial in Orlando, Florida, a brick bears the following inscription: "S. J. Gates, Staff Sergeant, Quartermaster, Truck Corps, Red Ball Express." And this brick is a symbol not just for what my father's life was, but for the foundation he laid for my life. Dad never had the opportunity to go to college. And yet, he had that dream for his children, which he fostered the entirety of our lives.

Related to his work in the military, he also had a fascination with mathematics, trigonometry, and he enjoyed studying equations. And I can remember watching at Fort Bliss as this happened.

At the start of the Space Race, he started buying books about it for me. I was born in 1950, so by the time I was learning to read, no one had ever been into space. I learned that those sky—the lights in the sky were places to which one could go. And I began dreaming about becoming an astronaut. But, I knew science was the way that you got there.

In 1969, I entered MIT. Four years later, I earned two bachelor's degrees, the first in math, the second in physics. And in 1977, I graduated with my Ph.D. in physics. From there, I went to Harvard and Caltech to do research on string theory, which even was starting then. And my research has always been supported by the National Science Foundation, at this boundary of mathematics and physics, in a subject called "supersymmetry."

In 1998, President Clinton announced that the United States would support research at the Large Hadron Collider in Geneva. And if this idea of supersymmetry is correct, we will find new forms of matter and energy, and perhaps some solutions to our problems.

As the Chairman of the Physics Department at Howard, capacity-building was my goal. As a result of my efforts, within 3 years there, we had $12 million of new sponsored research, sponsored by the National Aeronautics and Space Administration and the Department of Energy. I understood the power of partnering with government agencies.

My outreach for STEM spans the world. I've done public lectures, science documentaries, and DVDs with a teaching company. And the National Science Foundation encourages scientists like me to get out and talk to the public about what it is that we do.

So, that's it for my part of this story, as you can see, it's woven throughout, with connections to actions that are carried out by this body.

Regarding improvement in diversity, a fundamental observation of the No Child Left Behind Act was, many minority students are relegated to schools with poor teacher effectiveness. I'm a college professor, and I actually see the effect of this as students enter college in their freshman year. Diversity is a critical issue, and yet, when we find our minority students entering college, often they are discouraged.

Last Fall, I met with a group on campus called "Achieving College Excellence." It's designed for students who are struggling in their first year. I remember seeing the faces of young African-American students, in particular, who were told, for the first time in their lives, "Your past accomplishments in math were not sufficient." They had been caught and betrayed by the gap in teacher preparation that they acquired to that point.

I'm going to defer the rest of my comments to the written record and simply go to the end.

I thank this committee for the opportunity to speak today on the matter of pressing concern to me as an educator, a parent, a scientist, and somewhat as an educational policy wonk. I ardently wish that my family, community, and Nation—a Nation, in the century ahead—will witness a continuation of what I think is perhaps the sweetest dream of humanity, the American dream.

My STEM story is full of examples where the Federal Government supported acts, like the America COMPETES Acts, that allowed a—the grandson of a poor Alabama sugarcane farmer to become a theoretical physicist. Your authorization, or reauthorization, of this Act can help the next generation to achieve their dreams in the same manner.

Thank you.

[The prepared statement of Dr. Gates follows:]

PREPARED STATEMENT OF DR. S. JAMES GATES, JR., JOHN S. TOLL PROFESSOR OF PHYSICS AND DIRECTOR, CENTER FOR STRING & PARTICLE THEORY, PHYSICS DEPARTMENT, UNIVERSITY OF MARYLAND

Good morning, Chairman Rockefeller, Ranking Member Hutchison, and other members of the Committee. I also wish to greet my fellow witnesses and all who work to secure the brightest possible future for our Nation.

Thank you for inviting me to testify on the subject of "America Wins When America COMPETES: Building a High-Tech Workforce." I am Jim Gates, the John S. Toll Professor of Physics and Director of the Center for Particle & String Theory in the Department of Physics at the University of Maryland, College Park.

The letter from Chairman Rockefeller asked me to speak on four points:

a. my own STEM story,

b. ways to improve diversity in STEM fields,

c. ideas to produce more qualified STEM teachers, and

d. a perspective and recommendations on national STEM programs and policies.

I emphasize my comments and perspectives are personal ones. I am not speaking on behalf of any organization or group with which I am affiliated.

Point 1: My STEM Story

The story begins with my grandfather, Joseph Gates—a poor but land-owning farmer—in the area of Linden, AL. Though Joseph could neither read nor write, apparently he had a "knack for ciphering" (*i.e.,* arithmetic) and he was fond of saying, "People don't mind being around people who know how to work." Together with his wife Annie Lee Hudson Gates, they became the parents of Sylvester James Gates, Sr. Near the Battle of the Bulge Memorial at Lake Eola in Orlando, a brick bears the following inscription, "S. J. Gates, Sr Staff Sergeant, Quarter Master Truck, Red Ball Express," a symbol of a young man who decided he would leave the farm to seek a better life. Metaphorically, the brick described above has an even greater significance to me. It represents a foundation laid for my life.

In 1941, S. J. Gates, Sr., began his 27 years in the U.S. Army including 13 months in the European Theater of Operations. By 1961, he had obtained the rank of Sergeant Major and on that occasion said, "I hope I may continue to serve my country in a manner that is worthy of the honor it has given me." My father never had the opportunity to attend college (as was the case for all members of his family), but he did have a fascination with mathematics. I recall watching him at the study

of trigonometry on the post at Ft. Bliss. He especially enjoyed his command of understanding equations describing motion. These are related, of course, to artillery accuracy.

During the start of the "space race," he brought home books about it for me to read. These fired my imagination with the idea that the lights (stars) seen in the night sky were places to which one might travel. I dreamed of becoming an astronaut, but also instinctively knew that science was the means by which one might reach the stars . . . however distant. This marked the beginning of my lifelong pursuit of the study of science . . . and just missing the chance to become an astronaut.

In the Fall of 1969, I became a freshman at the Massachusetts Institute of Technology (MIT), the first of my family to reach college, with part of the expenses covered by a National Defense Student Loan. I received Bachelor of Science degrees in mathematics and physics in 1973. Four years later, still at MIT, I was granted a Ph.D. degree in physics with my father attending the graduation ceremony.

My research has focused on a topic at the boundary of math and physics starting in 1977 when I wrote a thesis on a topic called "supersymmetry." The National Science Foundation has provided invaluable support for this sort of research over the years. Supersymmetry is one of the main properties of nature under investigation at the Large Hadron Collider. The Department of Energy has supported the construction of the major scientific instruments there as well as hundreds of U.S. scientists who designed, built and operate them. If new forms of matter and energy predicted by supersymmetry are discovered, it will have been unwritten by the actions of the U.S. Congress.

As Chair at the Howard University physics department, capacity-building was my goal. As a result within 3 years, there were over $12 million in new sponsored research activity in the department. One source was a large grant from the National Aeronautics and Space Administration (NASA). A second grant, from the Department of Energy (DoE), was the largest single DoE research grant ever made to an HBCU. I understood the potential for a transformation in a STEM field with the assistance of government agencies.

My outreach efforts on behalf of STEM fields have occurred via public lecture, television science documentary, and DVD presentations in efforts to broadly communicate fundamental science. These experiences have shown me how difficult it is for these subjects to be communicated in clear ways beyond the laboratory or university. The National Science Foundation has played a major role with its support of documentaries like 'The Elegant Universe' where many physicists (including me) told a story from the frontier of physics.

A member of an international panel that provided recommendations to the government of South Africa on its national physics infrastructure, I participate in activities linking the African continent.

The "broad impact" requirement of grants given by the National Science Foundation encourages scientists to take on responsibilities of communicating science broadly.

Point 2: Regarding Improvement Of Diversity in STEM Fields

A fundamental observation related to the No Child Left Behind (NCLB) Act of 2001, was that many minority students are relegated to schools where teacher effectiveness is low. This is an even greater challenge in STEM. The No Child Left Behind Act marked the first time the Federal Government made a commitment to address this problem. As Secretary of Education Duncan has said,

"You all well know that it is hard to teach what you don't know. When we get to sixth, seventh, and eighth grades, we see a lot of students start to lose interest in math and science, and guess why, because their teachers don't know math and science so it is hard to really instill passion and a love for learning if you are struggling with the content yourself."

If we wish for this Nation's diversity to be demonstrated in STEM areas, we must provide incentives for gifted and effective STEM teachers to go where they are needed. The Obama administration's recent "Blueprint for Reform," underscores this core principle.

Diversity is a critical issue, particularly in the STEM fields. The Olympics give us an example of how diversity is addressed in a positive way. America's athletes have benefited from the full participation of citizens across the widest demographic spectrum. I believe the same could happen in STEM fields. New perspectives offer the possibilities of new breakthrough innovations.

What are the concrete ideas that might allow for such increases of a diverse STEM community? Currently there are few examples in the kindergarten to twelfth grades. Among these are the projects known as the Harlem Children's Zone, San Diego's High Tech High, and the Knowledge Is Power Program (KIPP) schools lo-

cated in 21 states. They seem to be able to close the persistent gaps in the science and math performances of African-American and Hispanic students in comparison to the total national performance.

As a professor, I have seen what this gap does to young students as they enter college. At the University of Maryland, we have the Achieving College Excellence (ACE) program (among others) to assist with this transition. In the fall of 2009, I saw the pain and discouragement on the faces of some of our African-American students, when told for the first time, "Your past accomplishments in math are not sufficient." They entered thinking themselves prepared to take on the challenge of college math only to find the gaps inherent in their K–12 education betrayed them. At this point some vocally began consideration of not majoring in STEM fields. Support of the core principle that effective STEM teachers should be available to all students seems critical if this is not to be the fate of similar students in the future.

Point 3: Ideas To Produce More Qualified STEM Teachers

I defer this question to my fellow witness Mr. Luce, the former Assistant Secretary of Education for Planning, Evaluation and Policy Development. I believe, in his current role as the CEO of the National Math & Science Initiative, he has a terrific story to tell regarding development of programs to reach this goal.

Point 4: Perspectives and Recommendations on STEM Programs and Policies

Our nation faces a point I call "an instant of destiny" when we must act boldly, with insight and determination, to support fundamental educational reform, especially in STEM fields, to secure our future economic prosperity.

Several weeks ago, I addressed the recipients of the President's Award of Excellence in Math & Science Teaching (PAEMST). Multiple personal and professional perspectives convinced me a certain title, "The Third STEM Crisis," was appropriate. I suggest there have been two other similar crises in the past one hundred years:

1. World War II, and
2. the launch of Sputnik.

A key reason for the U.S. victory was innovation and mastery in STEM fields. However, for someone interested in policy, a more subtle and powerful example of how World War II shaped the future of innovation is from the paper, "Science: The Endless Frontier" by Vannevar Bush and written in 1945. He described how the crisis of war acted as a crucible to forge new capacities in our Nation and why these should not be allowed to dissipate as we left the wartime environment. In 1950 a government structure dedicated to the preservation and stewardship of this innovative capacity was inaugurated in the National Science Foundation.

Within a decade, the launch of Sputnik caused a similar transition in capacity. Once more there is a "front page story" with of the creation of NASA and the "space race." However, there were other policy related stories—the creation of the Defense Advanced Research Projects Agency (DARPA) and the National Defense Education Act (NDEA). In these crucial circumstances, the U.S. Congress understood and extended national structures related to STEM areas.

We face a third STEM crisis. Today's world is one where STEM fields have become directly related to the ability of modern societies to generate wealth and provide for a vibrant economic environment for their citizens. If we want the most vital U.S.A. to exist tomorrow, we must plant the seeds for that today by investing in the strongest possible STEM education for all our citizens. The third STEM crisis is our current underperformance in STEM education today!

We, as a country, must consider the creation of new national structures that at a minimum:

a. focus on the practical processes of innovation in the realm of education as DARPA does,

b. seek to foster public/private partnerships to bring solutions to scale by working with industry, universities, after- and out-of-school programs, state and local stakeholders,

c. engage state-led efforts to create pathways by which highly effective teachers of the STEM fields are made accessible to all American students, and

d. identify policy tools (new and old) by which the Federal Government can better organize itself and effectively work with state and local districts to overcome this third STEM crisis.

Reaching the President's goal of moving American students, ". . . to the top of the pack in science and math over the next decade," will require continuous dedication by our entire society, similar to the continuous dedication of Congress in passing the Morrill Acts, the G.I. Bill and a long list of actions going back to the 1830s.

In the most emphatic way, I urge you to reauthorize the America COMPETES Act. The COMPETES Act authorizes, directly and indirectly, the resources to enhance STEM education by funding both education programs at the K–12 level and research that enhances the education of under-graduate and graduate students and postdoctoral scholars.

I thank the Committee for the opportunity to speak today on this matter of pressing concern to me as an educator, parent, scientist, and educational policy "wonk." I ardently wish for my family, community, and Nation a century ahead that will witness a continuance of what is perhaps the sweetest dream of humanity . . . the American Dream. My STEM story is full of examples where federally supported acts, like the America COMPETE Act, allowed the grandson of a poor Alabama sugar cane farmer to become a theoretical physicist. Your reauthorization of this Act can help the next generation to achieve their dreams in the same manner.

The CHAIRMAN. Thank you very much, Dr. Gates.

Dr. MIAOULIS. "Meeowliss."

Senator REED. Ioannis—no, no, I've got to get it—Ioannis Miaoulis.

Dr. MIAOULIS. Very good.

STATEMENT OF DR. IOANNIS MIAOULIS, PRESIDENT AND DIRECTOR, MUSEUM OF SCIENCE, BOSTON AND FOUNDING DIRECTOR OF THE NATIONAL CENTER FOR TECHNOLOGICAL LITERACY

Dr. MIAOULIS. Thank you. Thank you, Mr. Chairman. Thank you, Ranking Member and members of the Committee, for inviting me here.

I'm Ioannis Miaoulis, President and Director of the Museum of Science, Boston, and Director of the National Center for Technological Literacy.

I feel honored to be invited back. I testified here 4 years ago. And a lot of things have changed. It's wonderful to hear Senator Rockefeller and Senator Hutchison talking about technology and engineering within STEM. Four years ago, it was only about math and science. And you may recall that, 4 years ago, I encouraged this committee to start focusing in—on technology and engineering.

If you look at what kids learn in science in schools, it's pretty much all about the natural world. They learn about rocks and bugs and dinosaurs, the water cycle, the human body, physics principles, chemical reactions. And they learn very little about the human-made world. However, if you look at the world around us, most of the stuff we deal with are human-made. If you look at this room and you take away the human-made objects in this room, there would be no microphones, there would be no tables, no chairs, no carpets, no building, no clothes, and most of us would not be here, because, without pharmaceuticals, which are human-made, the life expectancy is about 27.

However, all these parts of the world, 98 percent, I would argue, of the world around us, is not part of the K–12 curriculum. And this is what technology and engineering could teach kids—children how the human-made world around us works and how it is made. So, in parallel with kids learning the inquiry process—how scientists discover—they're learning the engineering design process—how engineers design.

Another necessity of having technology and engineering is simply to support American competitiveness. American competitiveness depends a lot on the engineering work force. However, only 5 percent of U.S. students choose engineering as a major, compared with 13 percent of the students in Europe and 20 percent of the students in China.

So, why does the Museum of Science in Boston champion the introduction of technology and engineering? If you want to make a wholesale change in the Nation, so that everybody appreciates technology and engineering and kids are motivated to go into technology and engineering, you first have to change schools by introducing, as part of the formal core curriculum, technology and engineering. And second, you have to influence adults—the parents. And science centers and museums offer a wonderful way to influence adults, along with places like the Discovery Channel, to appreciate technology and engineering.

So, I encourage this committee to keep supporting informal science education venues, such as museums of science, and TV channels, to encourage all citizens, both adults and children, to appreciate science and technology.

We have made a lot of progress over the last 4 years. The National Governors Association has placed a special focus, within its efforts to support STEM, to support technology and engineering. If you look at the national report card, the new standards for NAEP, now 10 percent of the science test includes engineering. There will be a new national test on technology and engineering, starting in 2014—a new NAEP test. We have numerous States, now, having technology and engineering standards. It was only Massachusetts, last time we talked about. Now most of the states have engineering standards.

And if you look at what the Museum's progress has been, the last time I present to you, we were working with a few hundred teachers and a few thousand students, and now we're up to 25,000 teachers, and over a million and a half students use our engineering materials throughout the country, in all 50 States.

The most exciting recent development in K–12 engineering was the introduction of the Engineering Education for Innovation Act, a bill in the Senate. Some of the Senators that supported this bill are actually here. We have—the Senators who supported the bill were Senators Gillibrand, Kaufmann, Snowe, Cantwell, Klobuchar, and Murray. And also, in parallel, we had the companion bill, introduced by Representative Paul Tonko, the same day.

I have four recommendations, and some others that are in my written testimony:

First, it would be wonderful if this new bill, the Engineering Education for Innovation Act, becomes part of America COMPETES Act. That would be a great start of the initiative. And this bill will enable all students in all states to engage in learning engineering, from kindergarten on.

The second recommendation is that this committee support NASA's ability to become a national visible champion of engineering in this country. NASA is the most powerful and visible engineering entity in the world, and I think we're missing an oppor-

tunity, not having a place like NASA to become the public spokesentity to inspire kids to pursue engineering.

My third recommendation is about the National Science Foundation. Most of the new funding at NSF is focusing on research, how we should research to understand how kids learn science and technology and engineering and mathematics. However, I think, in parallel, NSF should be funding development of new materials, especially in areas where new materials are not abundant, such as engineering.

And the fourth recommendation is to continue supporting the formal science centers in supporting the whole engineering and technology and math and science learning of children.

I would like to thank, again, the Committee for supporting technology and engineering, and I hope that it will continue to do so.

[The prepared statement of Dr. Miaoulis follows:]

PREPARED STATEMENT OF DR. IOANNIS MIAOULIS, PRESIDENT AND DIRECTOR, MUSEUM OF SCIENCE, BOSTON AND FOUNDING DIRECTOR OF THE NATIONAL CENTER FOR TECHNOLOGICAL LITERACY

Good morning and thank you, Mr. Chairman, Ranking Member, and members of the Committee. It is an honor to be invited back to discuss our Nation's ability to create a first class, competitive, and innovative workforce. My focus, and the work of the Museum of Science, Boston and the National Center for Technological Literacy® (NCTL®), is at the very beginning of that process, working with young students in elementary and secondary school.

One of the Museum's primary missions is to promote and be a resource for the advancement of science, technology and engineering education. As New England's premiere source of public learning experiences, the Museum of Science serves as the go-to place for educators, students, and the public wishing to explore the relationship between science and technology through exhibits, planetarium shows, the Lyman Library, courses, and programs for all ages and abilities. The Museum also collaborates with partners throughout the Nation to develop instructional materials and professional development programs for teachers and school administrators about how new technologies are created using the engineering design process.

The NCTL seeks to integrate engineering as a new discipline in schools nationwide and to inspire the next generation of engineers and innovators. The NCTL partners with educators, administrators, organizations, and industry representatives across the United States to introduce or modify standards related to technology and engineering and to provide cutting-edge curricular resources. Working together, we can engineer a better world for generations to come through our K–12 curricular and professional development programs, advocacy efforts, and museum programs.

Four years ago, I was invited to testify before the Science, Technology and Innovation Subcommittee to discuss K–12 engineering education, *Rising Above the Gathering Storm*, and what culminated in the America COMPETES Act (ACA). This ambitious, bipartisan effort helped rejuvenate our STEM educational and R&D obligations and placed a new focus on STEM as a national priority. Unfortunately, we have not been able to live up to many of the goals set forth under the law—particularly in providing resources for STEM education programs, including many programs at the Departments of Energy and Education. The requisite funding did not materialize to make all these valiant programs and promises come true. Although some programs were funded either through appropriations or the Recovery Act, my concern is that very little was done in the K–12 STEM education space and even less was done for informal science education.

Engineering Education Progress since Enactment of ACA

Despite the shortage of Federal funding, there have been a number of significant developments since the enactment of ACA that have helped advance K–12 STEM education, particularly technology and engineering education. (Why K–12 Engineering? See Appendix A.)

The National Governors Association's report, "Building a STEM Agenda,"[1] recommended that states should develop standards and assessments in technology and engineering as well as math and science. The NGA was able to provide grants to six states to build their STEM education infrastructure and the NCTL has served as a resource to the NGA Center for Best Practices in this regard working most recently with Ohio and Minnesota in revising their state standards to include engineering. The NGA is also working with the National Academies Board on Science Education on developing common core science standards that will most likely include the engineering design process.

The new National Assessment of Educational Progress (NAEP aka the Nation's Report Card) for Science administered in 2009[2] measured student technological design skills for the first time in history. The results will be available this summer. The NCTL worked to insure that this assessment include technological design because it resides in both the National Science Education Standards[3] and Benchmarks for Scientific Literacy.[4] The term "technological design" refers to the process that underlies the development of all technologies, from paper clips to space stations. The National Science Education Standards explain that this meaning "is not to be confused with 'instructional technology,' which provides students and teachers with exciting tools—such as computers—to conduct inquiry and to understand science."

In 2014, NAEP will administer the first-ever, computer-based assessment of Technology and Engineering Literacy.[5] Again, the NCTL worked to insure that engineering design be a component of this assessment, which was originally entitled "NAEP Technological Literacy." This assessment will have three topical areas—use of information and communication technology, engineering design and systems thinking, and technology and its impacts on society.

Engineering is also a key component of the Museum's informal educational programs and exhibits. The National Research Council report, "Learning Science in Informal Environments: Places, People, and Pursuits,"[6] found that, "tens of millions of Americans, young and old, choose to learn about science in informal ways—by visiting museums and aquariums, attending after-school programs, pursuing personal hobbies, and watching TV documentaries, for example." The report also notes that informal learning experiences can significantly improve outcomes for individuals from groups historically underrepresented in science.

In 2009, the National Academy of Engineering and the National Research Council released, "Engineering in K–12 Education: Understanding the Status and Improving Prospects,"[7] which found several potential benefits of K–12 engineering education, including improved learning and achievement in science and mathematics; increased awareness of engineering and the work of engineers; understanding of and the ability to engage in engineering design; and interest in pursuing engineering as a career; and, increased technological literacy. The report notes that several million K–12 students have experienced some formal engineering education. As of March 2010, one of our NCTL curricular projects, Engineering is Elementary,* has reached 18,200 teachers and over 1.1 million students in all 50 states and the District of Columbia and is highlighted throughout the report.

Since the enactment of ACA, numerous universities, community colleges, consortia and science museums have established or expanded engineering education programs for pre-service and in-service K–12 teachers.[8] We have partnerships in 20 states including ME, NH, TX, OH, ND, NC, MN, NJ, PA, etc. (Appendix B)

---

[1] National Governors Association, Building a Science, Technology, Engineering and Math Agenda, February 2007, page 2.

[2] National Assessment Governing Board, "Science Framework for the 2009 NAEP," September 2008, pages 76–80.

[3] National Science Education Standards, National Research Council, 1996.

[4] Benchmarks for Scientific Literacy, American Association for the Advancement of Science, 1993.

[5] National Assessment Governing Board, "National Assessment of Educational Progress (NAEP) Technology and Engineering Literacy Framework and Test Item Specifications," *www.edgateway.net/cs/naepsci/print/docs/470.*

[6] National Research Council, "Learning Science in Informal Environments: Places, People, and Pursuits," January 2009.

[7] National Academy of Engineering and National Research Council, "Engineering in K–12 Education," September 2009, pages 49–62.

[8] A sampling of Institutions with of pre-service and in-service K–12 engineering education programs: Stevens Institute of Technology, Virginia Tech, Purdue University, North Carolina State University, Valley City State University, Holyoke Community College, Fitchburg State College, National Center for Engineering & Technology Education, Museum of Science, Boston, Science Museum of Minnesota, Oregon Museum of Science & Industry.

States are also increasingly incorporating engineering into their science standards and assessments, like Massachusetts, including Ohio, Minnesota, Oregon, Washington, and Tennessee (Appendix C).

The professional association for technology teachers recently changed their organizational name to the International Technology and *Engineering* Education Association to better reflect the content of their instruction. This organization is also responsible for the development of the "Standards for Technological Literacy,"[9] which most states have adopted, that includes the designed world and the engineering design process.

By far, the most exciting recent development in K–12 engineering education is the introduction of S. 3043 on February 25, by Senators Gillibrand, Kaufman, Snowe, Cantwell, Klobuchar, and Murray. A companion bill, H.R. 4709, was introduced by Representative Paul Tonko on the same day. More than 100 organizations are supporting this bill, including Intel, IBM, and Lockheed Martin. (Appendix D)

The Engineering Education for Innovation Act (E^2 for Innovation Act), based on the findings of the NAE K–12 Engineering report, will support K–12 engineering education and related evaluation research. In general, this legislation authorizes the Secretary of Education to competitively award planning and implementation grants for state educational agencies to integrate engineering education into K–12 curriculum and instruction. It also funds the research and evaluation of such efforts. Specifically, the E2 for Innovation Act will enable states to:

- integrate engineering education into K–12 instruction by designing challenging content and curricula frameworks and assessments that include engineering;
- increase engineering and technology teacher preparation programs and recruit qualified teachers to provide engineering education in high-need schools;
- increase student achievement in STEM subjects and knowledge and competency in engineering design skills;
- promote aspirations for a career in engineering among diverse student populations, especially among girls and underrepresented minorities;
- invest in afterschool engineering education programs; and
- promote partnerships among K–12 school administrators and teachers and engineering professionals.

Recommendations

Given these positive developments in K–12 engineering education and informal science learning, and on behalf of the Museum of Science, our National Center for Technological Literacy, and hundreds of like-minded organizations, I offer the following policy recommendations as you consider reauthorization of the America COMPETES Act:

First and foremost, Congress should enact S. 3043 as part of America COMPETES or included as part of the STEM initiative under the Elementary and Secondary Education Act (ESEA). K–12 engineering education will catalyze the development of a highly skilled STEM workforce necessary to insure our global competitiveness and national security.

Congress should highlight and support NASA's ability to be a leader among Federal agencies in K–12 and informal engineering education. As a member of the NASA Education and Public Outreach Committee, I am alarmed by all the reports that NASA will face a shortage of engineers in the near future due to retirements. NASA is unique in its ability to inspire students to pursue high-tech careers in engineering and the Congress should continue to make this issue a priority for the agency and direct programmatic support and funding accordingly.

Congress should highlight and support NSF's commitment to Education and Human Resource development by providing for a balanced portfolio of research and development funds. The recent shift in focus to research has shortchanged the development of innovative interventions. The House COMPETES bill, H.R. 5116, includes many important provisions for informal science education and engineering education research. I also believe that broader impacts and greater public understanding can be achieved if grantees are directed to partner with outreach entities, such as informal STEM education institutions that have a proven record of success communicating STEM research to the general public.

We support efforts to improve coordination among the Federal agencies on STEM education and the creation of a STEM advisory committee of relevant stakeholders

[9] International Technology and Engineering Education Association, Standards for Technological Literacy, 2000, Standard 9, page 99–105.

including engineering education providers and informal STEM education institutions.

We urge Congress to support the President's proposed RE-ENERGYSE—Regaining our Energy Science and Engineering Edge—initiative at the Department of Energy that includes K–12 and informal educational components to promote and support innovative approaches to foster sustainability and energy literacy.

Finally, the Museum is also concerned with public education concerning new technologies and in public engagement with science and technology policy. The Museum has joined forces with the Science and Technology Innovation Program at the Wilson Center, the Consortium of Science, Policy, and Outcomes at Arizona State University, Science Cheerleader, and the Loka Institute to create a nationwide network to conduct Expert & Citizen Assessment of Science & Technology (ECAST). The ECAST network will combine the skills of nonpartisan policy research organizations with the research strengths of universities and the public outreach and education capabilities of science museums. By educating and engaging laypeople, participatory technology assessment enables decision-makers to learn of their constituents' informed views regarding emerging developments in science and technology. We urge Congress to support OSTP and GAO in efforts to support ECAST and engage the public in discourse about STEM-related policy issues.

Again, I thank the Chairman for the invitation to participate in this hearing and the Committee members for their attention to this issue of American competitiveness and K–12 engineering education. I look forward to working with this Committee, the Congress and this Administration in advancing an innovative U.S. workforce. Please let me know if you have questions or need additional information.

Appendix A. Why K–12 Engineering?

1. Technological Literacy is Basic Literacy

How can one claim to be literate if she does not understand how 95 percent of her environment works, or how it was made? Understanding how an engineer designs is just as important as understanding how a scientist thinks.

2. Engineering Promotes Problem Solving and Project-Based Learning

The Engineering Design Process starts by identifying a need or a problem. It follows an organized path to arrive at one or more solutions that satisfy the need or solve the problem. Problem solving skills are far more valuable than many of the other skills that are the focus of our K–12 educational systems.

3. Engineering Makes Math and Science Relevant

Engineering makes math and science relevant which is critical in the middle school and high school years. Relevance is particularly important for retention of girls in science fields. Girls gravitate toward science disciplines that have an evident benefit to society. Half of the medical school students are women, and women comprise the majority of students in the life sciences. In some highly competitive veterinary schools, more than 80 percent of the students are female. Ability is clearly not the limiting factor. Engineering in K–12 can make science relevant and improve student interest, especially among girls.

4. Engineering as a Career

In order to preserve the innovation culture in the U.S., numerous committees have issued reports calling for an increase in support of K–12 mathematics and science education. What these reports have missed is that the connector between math, science, and innovation is engineering. We also know that a majority of existing engineers where inspired to pursue engineering by a family member. If we want to diversify this workforce of predominantly white men, we cannot rely on them alone to expose and inspire the next generation of engineers. We cannot expect more high school students to enroll of engineering if they have never heard of it before. To broaden and diversify this pipeline or pathway into engineering, we must expose all students to engineering, starting in the very early grades, before they are able to opt out of an engineering or STEM career pathway. Unless this connection is made in school, the number, gender, and race of future engineers will continue to fall short of current and future demands.

5. Navigating in a Three-Dimensional World

We live in a three dimensional world and we should be able to conceptualize it as such. At times we all have to imagine and sometimes sketch things in three dimensions for considering optimal designs, for example when we redesign a kitchen or set up a warehouse. Children now spend most of their discretionary time in front

of 2-D screens, televisions, video games, laptops, MP3 players, and mobile phones. Building, tinkering, and other 3-D activities that previously engaged mostly boys are no longer the preferred pastime. We have started creating generations of people that will not be able to visualize and design in three dimensions. This will not only affect the abilities of future engineers, designers, and architects, but also deprive people from a basic life skill. By introducing engineering in K–12 schools we will remediate this issue for both boys and girls.

Appendix B. NCTL Partnerships and Collaborations

Formal Educational Partnerships

BEST—Building Engineering and Scientific Talent
National Defense Education Program, U.S. Department of Defense
Maine Mathematics and Science Alliance
Minnesota Department of Education
New Hampshire Department of Education
Stevens Institute of Technology, NJ
Transformation 2013, TX
Valley State City University, ND
Villanova University College of Engineering, PA

Educational Collaborations

Aldine Independent School District, TX
Bristol Community College, MA
Charles Dana Center, TX
Education Service Center (ESC) Region 1—Edinburg, TX
ESC Region 3—Victoria, TX
ESC Region 4—Houston, TX
ESC Region 9—Wichita Falls, TX
ESC Region 11—Fort Worth, TX
ESC Region 12—Waco, TX
ESC Region 16—Amarillo, TX
ESC Region 18—Midland, TX
Falcon School District #49, CO
Georgia Department of Education
Hofstra University, NY
Holyoke Community College, MA
Long Beach Unified School District, CA
Massachusetts Department of Elementary and Secondary Education, MA
Minorities in Mathematics, Science, and Engineering, OH
Mobile Area Education Foundation, AL
Montgomery County ESC—Dayton, OH
National Governors Association, Center for Best Practices
North Carolina State University, NC
Northern Essex Community College, MA
North Central Texas College, TX
Ohio Department of Education, OH
Oregon Museum of Science and Industry, OR
Oregon State University, OR
Pennsylvania Department of Education, PA
Purdue University, IN
Putnam County Education Service Center, OH
Sally Ride Academy, WI
Science and Math on the Move Center, OH
Science Museum of Minnesota, MN
Stark County Education Service Center, OH
Texarkana ISD, TX
Towson University, MD
Tufts University, MA
University of Louisville, KY
University of Maryland Baltimore County, MD
University of Alabama, Huntsville, AL
University of Cincinnati, OH
University of Texas—Austin
Vermont Department of Education, VT
Wichita Falls ISD, TX
Worcester Polytechnic Institute, MA

Appendix C. State Engineering Standards Snapshot

Massachusetts

In 2000, Massachusetts became the first state in the Nation to develop and adopt Science and Technology/Engineering standards and subsequently implemented a statewide assessment which measures technology/engineering knowledge and skills. Technology/Engineering is considered a core science content area.

Vermont

In 2000, Vermont standards included a strand entitled Science, Mathematics, and Technology, which focuses on design and technology, an integral part of engineering.

New Jersey

In 2004, New Jersey adopted New Jersey Core Curriculum Content Standards for Technological Literacy. Standard 8.2 states that all students will develop an understanding of the nature and impact of technology, engineering, technological design,

and the designed world as they relate to the individual, society, and the environment.

Maryland

In 2005, Maryland adopted the Voluntary State Curriculum (VSC) that identifies five overarching themes in Technology Education: the Nature of Technology; the Impacts of Technology; Engineering Design and Development; Core Technologies; and, the Designed World. Maryland differentiates Technology Education from Technology Literacy for Students (computer literacy skills).

New Hampshire

In 2006, the NH Department of Education recognized the importance of "enabling our children to understand how humans modify the natural world to solve problems and to meet human needs and desires is equally as important as teaching them how to inquire about the natural world," and modified their curriculum framework to include design technology.

Texas

In 2007, the Texas legislature enacted a requirement for 4 years of high school science; engineering is a considered an eligible science course. Since Spring 2008, writing teams have been working to review the current Texas Essential Knowledge & Skills (TEKS) and make recommendations for revisions. One of the clusters is Science, Technology, Engineering and Mathematics

Tennessee

In 2007, Tennessee revised their state K–8 science standards by embedding both inquiry and technology and engineering design. For example, in grade four, students should be able to: describe how tools, technology, and inventions help to answer questions and solve problems; recognize that new tools, technology, and inventions are always being developed; identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem; and, recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

Oregon

In 2009, the Oregon Department of Education that revised their state science standard into four core strands: Standard I, *Structure and Function,* and II, *Interaction and Change,* describe the big ideas in the three science disciplines of physical, life, and Earth and space. Standard III, *Scientific Inquiry,* and IV, *Engineering Design,* describe the science process skills and understandings that characterize the nature and practice of science and engineering design. These process standards are intended to be interwoven with content in the three science disciplines.

National Governors Association STEM Grant States

In 2007, NGA awarded six states: Colorado, Hawaii, Minnesota, Ohio, Pennsylvania and Virginia $500,000 matching grants to establish science, technology, engineering and mathematics (STEM) education centers in their states. The grants are helping states create new or repurpose existing STEM centers. The centers will serve as the foundation for an improved workforce by:

- Aligning K–12 STEM education requirements with post-secondary and workplace expectations;
- Improving the quantity and quality of STEM teachers;
- Benchmarking state K–12 STEM standards, assessments and curricula to top performing nations in STEM education achievement and attainment;
- Garnering public will for change to implement a better aligned system; and
- Identifying best practices in STEM education and bringing them to scale.

Appendix D. Organizations that Support S. 3043/H.R. 4709, the Engineering Education for Innovation Act (E^2) (as of 11/17/2010)

Quote from Norm Augustine, former CEO, Lockheed Martin Corporation, and Gathering Storm report committee member.

"One of the many reasons our Nation does not seem to attract young people into engineering is that many seem to have no idea what an engineer does. Although we attempt to teach math and science in K–12, seldom do we expose students to engineering. Congratulations on this fine effort (to introduce K–12 engineering legislation) . . . I believe it is well aimed."

1. Alabama Mathematics, Science, and Technology Education Coalition (AMSTEC)
2. American Chemical Society
3. American Society for Engineering Education
4. American Society of Civil Engineers
5. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
6. Arc Capital Development
7. ASME Center for Public Awareness
8. Association of Science and Technology Centers
9. Bechtel Power Corporation
10. BEST Robotics, Auburn University
11. Center for Innovation in Engineering and Science Education, Stevens Institute of Technology
12. Center for Mathematics and Science Education, Teaching and Technology at John Carroll University
13. Center for Mathematics, Science, and Technology
14. Center for Minority Achievement in Science and Technology
15. Center for the Advancement of STEM Education
16. Chicago Educational Publishing Company
17. Colorado Technology Education Association
18. Consortium for School Networking
19. Cuyahoga Falls High School Technology Education Department
20. Delaware Foundation for Science and Mathematics Education
21. Depco, LLC, Pittsburg, KS
22. East Central Ohio Technology Education Association
23. Eastwood Middle School Career Cluster Technologies, AL
24. Engineering & Technology Educators of Indiana
25. Hockaday School
26. Hofstra University Center for Technological Literacy
27. IBM Corporation
28. IEEE-USA
29. Illinois Mathematics and Science Academy
30. Illinois State University, Center for Mathematics, Science, & Technology
31. INSPIRE, Institute for P–12 Engineering Research and Learning, Purdue University
32. Intel Corporation
33. International Technology and Engineering Education Association
34. International Technology and Engineering Education Association/Council for Supervision and Leadership
35. JETS
36. Kentucky Engineering & Technology Education Association
37. Learning Institute for Technology Education, MI
38. LearnOnLine, Inc.
39. Lockheed Martin Corporation
40. Massachusetts Technology/Engineering Education Collaborative
41. MassTEC
42. Museum of Science, Boston
43. National Alliance for Partnerships in Equity
44. National Association of State Directors of Career Technical Education Consortium
45. National Center for Technological Literacy
46. National Council of Teachers of Mathematics
47. National Girls Collaborative Project
48. National Institute of Building Sciences
49. National Middle Level Science Teachers Association

50. National Science Education Leadership Association
51. National Science Teachers Association
52. National Society of Black Engineers
53. National Society of Professional Engineers
54. New Jersey Technology Education Association
55. New York Hall of Science
56. New York State STEM Education Collaborative
57. New York State Technology Education Association
58. North Carolina Technology Education Association
59. North Dakota State University's College of Engineering and Architecture
60. North East Ohio Technology & Engineering Educators Association
61. Ohio Engineering Deans' Council
62. Ohio Northern University
63. Ohio Technology and Engineering Educators Association
64. Ohio Technology Education Advisory Council
65. Ohio Technology Education Association
66. Pathways into Science
67. Pennsylvania Technology Student Association
68. Project Lead the Way
69. PTC
70. PTC-MIT Consortium
71. Real World Design Challenge
72. Rensselaer Polytechnic Institute, School of Engineering
73. Science Museum of Minnesota
74. Skillpoint Alliance
75. Sloan Career Cornerstone Center
76. Society of Women Engineers
77. South Carolina's Coalition for Mathematics & Science
78. Stevens Institute of Technology, Center for Innovation in Engineering and Science Education, NJ
79. Teachers Clearinghouse for Science and Society Education
80. Technology Education Association of Maryland
81. Technology Education Association of Pennsylvania
82. Technology Education Department at Cuyahoga Falls High School, OH
83. Technology Is Elementary
84. The CAD Academy
85. The Engineering Place at North Carolina State University
86. The Learning Institute for Technology Education
87. The Ohio Academy of Science
88. The Pittsburgh Regional Center for Science Teachers
89. The STEM Academy
90. The Teachers Clearinghouse for Science and Society Education
91. Triangle Coalition
92. Tuscaloosa City Schools, Career Cluster
93. Tuscaloosa Magnet Middle School
94. University of California
95. University of Pittsburgh at Johnstown
96. Urban STEM Strategy Group, Philadelphia
97. Valley City State University, ND
98. Vernier Software & Technology
99. Western Illinois University College of Business and Technology
100. Western Illinois University School of Engineering
101. Wisconsin Science Network
102. Wisconsin Technology & Engineering Education Association

103. Worcester Polytechnic Institute, K–12 Outreach Office

The CHAIRMAN. Thank you, sir.
Mr. Luce.

STATEMENT OF TOM LUCE, CHIEF EXECUTIVE OFFICER, NATIONAL MATH AND SCIENCE INITIATIVE

Mr. LUCE. Senator, and my home Senator, Senator Hutchison, and all members of the Senate, thank you so much for the opportunity to be here.

I want to emphasize several things. One, the National Math and Science Initiative is a unique organization, in that it was funded and started by the private sector to get the private sector to help support implementation of the America COMPETES Act. Private sector said, "What you did is important." ExxonMobil, the Gates Foundation, the Dell Foundation funded us with $140 million and said, "Go forth and try to make work what is in the America COMPETES Act, with private funding." That's what we've done. We took two recommendations from your programs that were in Rising Above the Gathering Storm, UTeach, and the Advanced Placement Incentive and Training Program, and we've spread those to 15 states with private funding.

The Advanced Placement Incentive and Training Program encourages high school students to take and pass advanced placement math and science and English courses. It does that by professional development to the existing teacher corps, just as Ms. Naylor talked about.

Number two, giving incentives to teachers and students to achieve passing those tests and scores. In the first year of operation in six States, we produced a 52-percent increase in the number of students taking and passing advanced placement math, science, and English courses. Fifty-two percent in one year.

Second of all, we're implementing the UTeach Program across the country. As Senator Hutchison said, it started at one university. We now have that program in 23 universities across the country. Now, what's relevant to reauthorization is, we have a huge waiting list. The private sector has invested $200 million. We urge you to invest alongside with the private sector to replicate these two programs.

The UTeach Program, as Senator Hutchison knows, takes entering college freshmen. They enter the College of Natural Sciences and Math. They get the same B.S. and that any other student does at the university. And they graduate in 4 years with a content degree in math, science, engineering, technology, and a teaching certificate. Now, the data shows—this program's been in existence 13 years—92 percent of the students who enter that program go into teaching. Number two, 82 percent are still teaching, 5 years later. Why? Because they've been trained in content knowledge. They can make a youngster's eyes light up. They know the content they're teaching. So, despite all the problems of teacher pay and working conditions, teachers are achieving wonderful results when they get the training that Ms. Naylor is talking about.

We, in the private sector, have done this in 23 universities, and we have 40 universities who have said, "We'll implement this pro-

gram if you'll help us." We're doing this for an investment of $2.5 million per university over 5 years. And we will be producing 10,000 math and science teachers within the next 3 years.

There's no reason we can't do this across the country. In one fell swoop—$2.5 million times 50 universities on a waiting list—we could train the next generation of math and science teachers, just the way you all wanted it done. But, we need some help. We have a waiting list. We're ready to go.

What we also need this committee to consider is when you reauthorize America COMPETES, let nonprofit entities, such as the National Math and Science Initiative, compete for the grants so that we can be the implementation arm to ensure faithful replication of these programs, and enforce accountability to ensure the university implements the program faithfully and does what's called for in the grant.

We can raise matching funds, but we need the Federal Government to step up. We say this is a national issue. Well, we need the Federal Government to help. States are investing in this program. The private sector's investing in this program. But, we need to the help of the Federal Government.

You all have been leaders in making us more competitive. What I feel very strongly about, the true stimulus program for this country is competitiveness. We can deal with short-term problems from now until doomsday, and if we don't increase our competitiveness, then we'll never begin to get all the jobs that we need in this country.

So, we thank you for your leadership on this issue. We stand ready. Our whole organization is predicated upon implementing what's in "Rising Above the Gathering Storm." We were formed by four members of the "Rising Above the Gathering Storm" advisory panel. Our mission is to ensure that you succeed. And we appreciate your leadership very, very much.

[The prepared statement of Mr. Luce follows:]

PREPARED STATEMENT OF TOM LUCE, CHIEF EXECUTIVE OFFICER, NATIONAL MATH AND SCIENCE INITIATIVE

Importance of Science, Technology, Engineering, and Math (STEM)

STEM fields offer the fastest growing and highest paying jobs in our economy. More than 50 percent of the fastest growing jobs in the United States are in STEM fields [1] and the science and engineering workforce has shown sustained growth for over a century. STEM jobs continue to grow much faster than the rest of the U.S. workforce [2] and workers with science and engineering degrees earn more than comparable workers.[3] These statistics illustrate that math and science education is absolutely critical to ensuring the country's economic prosperity. Math and science are creating a pipeline for more competitive workers and providing opportunity for future generations.

Currently, students in the U.S. perform below students from other industrialized countries in math and science. In a report issued by the Organization for Economic Cooperation and Development (OECD), the U.S. was classified as "statistically below OECD average" in both science knowledge and mathematics on the 2006 PISA survey. Just as troubling, according to the Bureau of Labor Statistics, a mere 5 percent of U.S. college students graduate from college in math and science fields, compared to 42 percent in China.

---

[1] U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook, 2008–09 Edition.

[2] National Science Board, Science and Engineering Indicators 2010.

[3] National Science Board, Science and Engineering Indicators 2010

Making STEM Education Work

To close this gap, we must scale what works. For years, we've been pursuing pilot program after pilot program, but we have yet to make a lasting difference. Scaling effective, proven programs is the only way we will change an education system with over 50 million schoolchildren.

The Federal Government can play a key role in this improvement of STEM education by identifying what works and providing incentives to scale those interventions at a national level. Congress and the Administration can also take several other steps to facilitate this change.

1. Congress should continue holding schools accountable for math and science by including accountability provisions in these subjects in any reauthorized version of the law.

2. Congress should work with the National Science Foundation (NSF) to more aggressively pursue education reform and provide support for states in implementing STEM strategies. Most importantly, Congress should work to provide an avenue for NSF to scale its most promising investments. This will ensure that the important work funded by NSF will be replicated and expanded to make a lasting difference in STEM education.

3. The Federal Government should provide priority points for STEM in all competitive education programs.

4. Congress should fund expansion of programs that work, such as the UTeach Program and the Advanced Placement Training and Incentive Program.

Scaling Works—Specific Examples of Success

The National Math and Science Initiative (NMSI) was launched in 2007 by top leaders in business, education, and science to reverse the troubling decline in American math and science education. NMSI is dedicated to dramatically impacting the U.S. public school system by replicating programs nationally that have documented success in math and science education. Inaugural funding for NMSI was provided by the Exxon Mobil Corporation, the Bill & Melinda Gates Foundation, and the Michael & Susan Dell Foundation.

According to the Business-Higher Education Forum, there will be a shortfall of more than 280,000 highly qualified math and science teachers by 2015. It is clear that talented math and science teachers with strong content knowledge are urgently needed in classrooms across the country to help our students reach their full potential. To address this urgent need, NMSI identified two initial programs to scale nationwide: the UTeach Program and the Advanced Placement Training and Incentive Program.

The UTeach Program transforms the way universities prepare math and science teachers. Developed at The University of Texas at Austin in 1997 to change the way colleges and universities recruit, prepare, and inspire new math and science teachers, this highly effective program recruits math and science undergraduate majors to pursue a teaching career. UTeach graduates enter teaching at much higher rates than regular College of Education teachers and stay in teaching at much higher rates than the national average. In fact, 92 percent of UTeach graduates become teachers, and 82 percent are still in the classroom after 5 years.

In 2006, The University of Texas Austin had 450 students enrolled in its UTeach Program. In 2007, NMSI partnered with the UTeach Institute and led an aggressive, intentional scaling effort funded by the private sector to expand the UTeach Program to additional universities. By 2009, UTeach was expanded to 13 campuses and had over 2,600 students enrolled in the program across the country. This year, NMSI and the UTeach Institute were able to add a second cohort, bringing the UTeach Program to a total of 22 campuses this fall. The 22 universities replicating UTeach will prepare over 4,500 math and science teachers by 2015 and 7,000 by 2018. These new STEM teachers will have an impact on more than 20 million students over the course of their teaching careers.

However, more can be done. There is incredible demand and high growth potential for the program. In 2007, NMSI had 52 universities apply to replicate the UTeach Program and was only able to fund 13 sites. We've raised money to expand the program to additional campuses, but demand continues to increase. Currently, over 50 Association of Public and Land Grant Universities have committed to doubling their STEM teacher preparation production. Three state university systems have pledged to bring STEM teacher preparation reform to their state systems: the California University System, California State University System, and the Maryland system. Most of these universities still need the tools to help them meet the goal of bringing programs like UTeach to their campuses.

A program to fund the replication of the successful UTeach Program was authorized under the 2007 America COMPETES legislation, but was not funded. That program, Teachers for a Competitive Tomorrow, needs to be funded. The Federal Government has the unique opportunity to leverage the investments already made by the private sector to expand access to even more universities. The private sector has responded, the universities have responded, the students are willing—what is urgently needed now is Federal funding to make much more progress possible.

The other successful program NMSI has worked to bring to scale is the Advanced Placement Training and Incentive Program (APTIP). This program impacts the existing teacher corps by providing training to AP teachers and provides immediate opportunity for high school students to master college level work. APTIP increases teacher effectiveness and student achievement through a multi-faceted, comprehensive approach that includes: training, teacher and student support, vertical teaming, open enrollment, and incentives. Expanding Advanced Placement courses is a matter of equity, equal access, and equal opportunity for all students. APTIP empowers high-need, underrepresented students to succeed in rigorous math and science courses. This change transforms expectations for students and significantly improves college-readiness.

In 2007, APTIP was only available in Texas. Since 2007, NMSI has scaled it to six additional states: Alabama, Arkansas, Connecticut, Kentucky, Massachusetts, and Virginia. We have impacted more than 30,000 students and trained over 1,000 teachers. In NMSI's first school year (2008–09), NMSI schools had a 52 percent increase in AP exams passed in math, science, and English, which is over 9 times the national average. At the same time, NMSI schools showed a 71.5 percent increase in AP exams passed by African American and Hispanic students in math, science, and English. These results show that expanding this proven program could help reduce the minority achievement gap in our country.

But more can be done. With additional resources to leverage the private investments in the success of these programs, NMSI will be able to bring the benefits to thousands of more students nationwide.

It is this kind of systemic change that will increase the quality and quantity of our STEM graduates and ensure that the U.S. economy will thrive in the 21st century.

The CHAIRMAN. Thank you, sir.

I'll start the questioning.

This is directed to nobody in particular. It seems to me that a couple of issues have arisen. You're talking about universities. Susan Naylor's talking about up to that point. Now, if you're going to take engineering or if you're going to take technology or if you can take science and math—obviously science and math have an easier shot—you've got to deal with the boards of education. It's sort of my general impression that boards of education always have a superintendent of schools. So, it comes down to who decides what actually gets taught. There's a political tinge to that position, depending upon who the Governor might be. I don't like to say that, but I think there's some truth to it.

So, if you consider the influence of the boards of education or the superintendent of schools in allocating time and what can be taught, how are you bound, in secondary schools, so to speak, to follow his instructions? Can you deviate?

Second, when one goes to college, one's thinking about, "What do I want to be? What do I really want to be?" You're sort of getting into the preprofessional mode, already, in your thinking. That is not true, Ms. Naylor, in your case. Kids are just malleable. They're subject to really, really good teaching. But, that doesn't mean that they can influence the board of education, or that they are thinking about their professions, and therefore, particularly for technology and engineering, there has to be an ingredient in there, either excellent teaching or something which touches their futures, which I would think would be very hard to make happen.

Ms. NAYLOR. The common core standards that have just—are being adopted, I think, by 48 states right now, are going to provide some consistency, in terms of standards in math and science—well, all curricular areas. And I am impressed by this effort, because our children are becoming so mobile, and they're moving from State to State much easier than they did 50 years ago. With the common core standards, it's going to give a benchmark for everyone that's consistent. And textbooks, instead of having to devise 50 different versions of their textbook to meet 50 different versions of standards in each State, can start addressing one common core standard and embedding more professional development.

I have another thought, but I'll add it later.

The CHAIRMAN. Please.

Mr. LUCE. Well, I would also add to that, as we increase interest and we want to encourage youngsters to go into STEM, the teachers have to be prepared to teach those students. And we need to give them the higher-level courses. What is tragic, to me, is that our data shows if a youngster—if an African American youngster takes and passes an AP course in math or science, instead of 15 percent of African Americans graduating from college, 65 percent will. If it's a Latino, it goes from 15 to plus-60. That means higher-standard courses. And too many schools do not have higher-standard courses. And you can't keep that youngster interested if they're not challenged.

So, I think what we really must do is continue to work on the existing teacher core with the professional development Ms. Naylor talks about.

The CHAIRMAN. In my final minute, I want to ask about secondary level education. I think we emphasize too much sports in America. I think sports take away a lot from academic capacity. It's sort of like girls and boys getting interested in each other. Well, everybody gets interested in sports, and math teachers are also football coaches, and I don't think that's a really sensational idea. So, my question is, when you get your claws into a student's mind and you've turned them on and they really want to learn, how can you sustain that? Because, they go from you to another teacher and then to another level, and eventually end up at university, where they certainly do become preprofessional in their thinking. I remember the great teachers in my life; never forget them. But, it's a hard thing to sustain interest in something like technology or engineering, I would think, simply from a great teacher at the high school level or the junior high school level, because—isn't it hard for them to know where they're taking this?

Ms. NAYLOR. There is a lot of peer pressure on kids to go into sports. And I think a lot of parents are pressuring kids into sports because they see scholarships and ways to college behind those sports.

I like the idea that—I was talking to the gentleman to my left before the meeting. He was talking about providing after-school experiences in science and mathematics. There are a lot of children that stay after school, from 3 until 5 o'clock, in, generally, recess atmospheres, until their parents can come pick them up. If we could integrate math and science activities for them during that time when they are still at school, that would be an excellent op-

portunity to continue that spark that hopefully got ignited in their classroom.

Mr. ZASLAV. One encouraging thing that we see at Discovery is—you talk about sports—on many nights, ESPN is not the number-one network in America for kids, 12 to 22; Discovery is. And Discovery is about satisfying curiosity. And at the heart, with all of the activity, there is a real drive to learn, we believe.

That's why we launched—in addition to Discovery, the Science Channel and we're investing a significant amount of resources in this idea of satisfying curiosity with quality content. And then we take it into the schools. But, it's driven by this idea that it isn't just sports, that, for men and women, satisfying curiosity—science, the principles around STEM—are core and very interesting to people.

The CHAIRMAN. That's an entirely hopeful statement. I'm very glad you made it.

Senator Hutchison.

Senator HUTCHISON. Well, thank you all very much. I think this has been a wonderful hearing, already.

Let me ask Mr. Luce. The program UTeach, that I think is so important, and which I do want to expand in our reauthorization—it has been around for over a decade. Have you been able—or, have we been able to obtain information on improvements in student performance? And, also, the increase in numbers of students who have had STEM teachers going into the STEM college courses, have you been able to get any more information that will show success from that?

Mr. LUCE. Not yet, is the unfortunate answer, given the condition of longitudinal data systems in States. However, to every grantee to which we gave a grant, we're in the—they had to agree to supply that data to us. So——

Senator HUTCHISON. So——

Mr. LUCE.—5 years from now, I'll be able to answer your question.

Senator HUTCHISON.—what would your suggestion be on the things that we must do in the reauthorization that would be an improvement, other than what you said earlier in your testimony?

Mr. LUCE. I think, in addition to the nonprofit issue, which I think is very important, because a lot of universities will say they're doing the UTeach program, but they don't follow the essential elements of the program, which are very important.

But, second of all, we have learned, the Department, unfortunately, has interpreted, often, some of the grants that you have authorized as requiring that grants be used to transform the entire school of education and the way all teachers are trained. Well, we're focused on one slice, which is STEM, which is to train those teachers in a different way, which is to get math and science content. So, making it clear that funds can be used just to change the way we train STEM teachers would be a very important aspect.

When we're giving a grant of only $2 million, and they say, "We want you to transform the entire college of education," you can't do that. We can transform the way we train STEM teachers.

Senator HUTCHISON. Thank you.

Mr. Zaslav, I do want to commend you on the Discovery Channel. I have an 8-year-old and a 9-year-old, and there are two channels that they will go to, besides Cartoon Network. One is Discovery and one is Disney. Of course, Discovery is the one I encourage, but it's—getting them off Cartoon Network is a feat. But, you can do it, and you have been able to show that learning can be fun. And that's a real feat.

Let me ask you how you would address, on your channel, even more capability to expand on what we're trying to do, which is interest the young people at the earliest levels, so that they take the prerequisites in high school, which is one of the big problems we have. If we start in high school, it's too late to get the prerequisites to go into engineering, for instance. And so, what else do you have on your agenda that might dovetail in and even, maybe, be part of what Ms. Naylor was mentioning, which was after- school programs that could be more educational than the atmosphere that you described, which I think is absolutely prevalent in the after-school programming that I have seen?

Mr. ZASLAV. Thank you so much, Senator Hutchison.

One of the things that we've done is, invested in bringing our content and STEM-appropriate content into the classrooms. We're the number-one provider of digital content into classrooms around America. So, 90 percent of the classrooms that can receive digital content receive it from us. So, we've invested in bringing our content into the classroom.

Philosophically, it's based on a belief system that textbooks alone are not the way this new generation learns. And so, we're looking at, how kids consume content? And how do we give teachers content in that format? So, whether we put it in video, whether it goes on the web, whether it goes on an iPod. That's the first thing we do.

The bigger initiative that we have is the Science Channel, which is in over 60 million homes today. There are almost 100 million homes in America. So, everyone that has a digital box in America could have access to the Science Channel. Our hope is that the Science Channel be available to every child in America.

We're making available 1 hour of commercial-free programming that we're going to produce that pushes the STEM initiative directly. And then we will make that content available free in schools.

We're asking the cable operators for no additional fees to make it available to all students, so that every student that comes home from school will be able to go to the Science Channel and see STEM-related content. That is our mission.

Senator HUTCHISON. That's great.

Thank you so much.

Dr. MIAOULIS. Senator, could I follow up on this?

Senator HUTCHISON. Sure. Sure.

Dr. MIAOULIS. I think it has to be——

Senator HUTCHISON. The Chairman is turned around. Go right ahead.

Dr. MIAOULIS. Is it OK?

Senator HUTCHISON. Yes.

Dr. MIAOULIS. I think it has to be a comprehensive approach, and television can play a huge role in that. However, the problem we have in the United States is that—72 percent of engineers have had a relative that's an engineer—simply because kids don't know what engineering is. They think engineers drive trains, repair TVs. They have no idea what engineering is. So, TV can be very helpful. Discovery Channel is an exception, though. The only engineering hero in a network TV, prime time, is Homer Simpson right now—the cartoon character. So, that's the image of engineering.

Also, engineering has to be a discipline in schools, so kids learn it from very early on, so every kid, regardless of their family background in engineering, knows what it is, gets excited through TV; science centers play a huge role in that; and then learning it at school in a formal way.

The CHAIRMAN. Thank you very much.

And now Senator Begich, to be followed by Senator Klobuchar and Senator Thune. Thune's gone, so—and Pryor's gone.

STATEMENT OF HON. MARK BEGICH,
U.S. SENATOR FROM ALASKA

Senator BEGICH. Thank you very much, Mr. Chairman.

And thank you all for being here.

I come from a family of educators. Both of my parents were educators. My sisters are educators, my sister-in-law is an educator. I chaired the Postsecondary Education Commission for Alaska for 7 years. So, education is really a part of our family.

And I have to tell you, STEM is an incredible program. I was at last week's STEM and National Lab Day kickoff, which is a great combination, as well as, kind of, the additional piece they added, which was the arts, to it, which I thought was a very interesting—they actually said they should rename it to STEAM and put "Arts" in the middle of it. I'd be interested in your comment on that. But, I'll hold that for a second.

Let me, if I can—is it Mr. Zaslav?

Mr. ZASLAV. Yes.

Senator BEGICH. Did I say that right? I have a—curious—just like Senator Hutchison, I have a 7-year-old son—your HEAD RUSH, or your 1 hour of commercial-free time—when you offer that, when will you offer that? In other words, what time of the day will you offer that?

Mr. ZASLAV. It'll be from 4 o'clock to 5 o'clock.

Senator BEGICH. OK, So in peak time——

Mr. ZASLAV. Right.

Senator BEGICH.—for our kids.

Mr. ZASLAV. And we've spent some time out in Hollywood. We went and got Steven Spielberg, who's very interested in science, and he has agreed to be involved, *pro bono.* His big push is that he doesn't want to produce content so that only two-thirds of America can see it, but the poorest Americans can't. He has been working with us on trying to get the distributors to make it available to all—everyone in America.

Senator BEGICH. That's great. I'm a great believer in your channel, and my son is—I mean, he's doing—an old computer I gave him had QuickBooks on it, so he can write invoices, and he'll make

you up some checks and business cards and all kinds of things. So, he's well-versed in that, and he built a lot of things. And so, I think your channel is a really good channel.

Let me, if I can, to the rest of the group, and however—whoever want to respond to this. You know, in Alaska, it's a very rural state. And being able to, one, get curriculum out into the State, but also to get teachers trained in rural Alaska—I want to emphasize that; it's much different than rural Texas or rural West Virginia, where, if you decide to move, you just get in a car and drive down the street and you're in another town or in another school district. That's not the case. Some of our school districts are as big as three or four states, combined, in the sense of its size and geographic location.

So, I have a two-part. One is, How do you ensure that you can deliver—and ideas you might have on delivering education training in STEM to teachers for rural schools, but also recognizing there's also a cultural component of science. And in our state—and I've just—my staff gave me a great book, to display over here in the Smithsonian Institute, on science in the Yupik nation, or Yupik people. How do you meld that so it's relative to the folks within, for example, my State in certain communities in rural—I don't—Mr. Luce, if you wanted to, or anyone else wants to jump in.

Mr. LUCE. Well, I will respond by saying we're doing the Advanced Placement Incentive and Training Program virtually in South Dakota to rural districts. And in just 4 months, we were able to sign up a student from 55 percent of the school districts in South Dakota who took the course virtually. And I think we have to get to the point where we're doing that. That enables you, particularly in rural areas that don't have a physics teacher, don't——

Senator BEGICH. Right.

Mr. LUCE.—have a chemistry teacher.

We're also developing a virtual laboratory, which you can produce on a computer the actual instruments that would be used in a laboratory, which is essential.

So, I think we're there. If states will push it, I think we can do it.

Senator BEGICH. I would only add that, that's the assumption, that rural communities have high-speed broadband, which is not the case all the time, especially in Alaska. So, that is a challenge on—our committee has been working on, to ensure that we have that for delivery of tele-education, telemedicine, and other—but, your—I like the idea of the content. And kids grasp it much quicker there.

I will say in—Ms. Naylor, when you mentioned—and I—you were very good about it, on the core standards. There are 48 States—I'm embarrassed to say we are one of them that has not signed up yet. I've been pushing our Governor to do that, for all the reasons you just laid out. If we're going to be competitive in this world, on math and science, we have to at least be competitive among our own States. And I'm embarrassed to say our State is not one of those. So, I appreciate your politeness, in how you presented that, but I recognize it, and it is one we are continuing to push.

From a teacher perspective, how do you see that question on the rural content? And if you could——

Ms. NAYLOR. My job right now is as an instructional coach. I am—I don't want to say "farmed out," but I have four or five schools that I go into, and I model the instructional strategies and the instructional materials that are new and unfamiliar to teachers. I do it in their own classrooms with their own children so they can actually see them work. And West Virginia is just now completing a new math adoption. And so, next year, all of our materials are going to be new.

So, being assigned to five schools, I almost become a liaison on staff for them. And I move in and out of classrooms. The kids become familiar with me. I'm almost like another teacher on staff. And the teachers—you—it takes a while to build a relationship of trust with them. But, once they trust you, they open their classrooms and let you come in and model for them. And that collaborative partnership that's established between an instructional coach and a classroom teacher is very beneficial for the students and the teacher.

Senator BEGICH. Very good.

I—my time is up, but I want to thank you all for working on such a worthy endeavor.

I'm a big supporter of the reauthorization and the resources. Mr. Luce, you have laid out a really good point. The private sector has done a great job in putting resources. It's our time to now match up and do what we can to get that list shortened.

So, thank you all very much.

The CHAIRMAN. Thank you, Senator.

Senator Klobuchar.

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you, Mr. Chairman.

I appreciate our witnesses. You know, a few months ago, I went to my daughter—she's 14—her high school science fair. Her experiment, just so you know, Dr. Gates, not quite of your level, was measuring the amount of bacteria in prewashed versus unwashed lettuce. At the end of the experiment, she looked at the judges and said, "My advice: Wash your lettuce."

[Laughter.]

Senator KLOBUCHAR. But, what I saw at that science fair was just this incredible enthusiasm and interest of these kids as they went up there to get their honors. And I thought to myself that this enthusiasm and interest can't end on the stage of a high school science fair.

And I always think about those Beijing Olympics and the 3,000 perfectly synchronized drummers, and I remember watching that with my family, thinking, "We're in trouble," and that while those drumbeats are getting louder and louder, and they're building high-speed rail in Shanghai, we're still dithering, and while they're graduating more scientists and engineers, we're doing better, but we need to do even better than that. And so, that's why I'm so interested in this topic. I see it as purely how we need to move forward with an agenda of innovation. That's what they've done in our state.

You know, Medtronic started in a garage. 3M started as a sandpaper company. And we're now seventh in the country for Fortune 500 companies. So, we truly believe in science and innovation in our State. And that's why I supported the bill that you mentioned, Dr. Miaoulis, the E2 bill, as well as some of the other STEM research, and why I entitled my subcommittee "Innovation, Competitiveness, and Export Promotion."

So, I wanted to first talk, I guess, with the teachers about how you get these kids truly motivated, to get them interested in areas that can seem very technical when you're in elementary school, and what you think works the best.

Ms. NAYLOR. There are more and more inquiry-based materials coming into classrooms, where children actually get to experience both math and science, and develop their own conceptual knowledge. And these materials help enrich students that are ready for a challenge, and they also help remediate children who are—so, there are levels of differentiation in one activity, where every child's needs are met. And they all feel like they have succeeded by the end of that lesson, whether it's in science or math. And they go home, telling Mom or Dad, "Today, I was an engineer," or, "Today I was an astronaut." And that "I can" attitude—once the children have that, we don't want to take that away from that—them, because when they become—I guess an advantage we have in the elementary grades is that we don't give grades in science and math, in the lower grades. And so, there's not that grade hanging over their heads. I sometimes worry that when they get to middle school, they are so worried about the grade that it's, "Get the grade, however you can," and they lose that intrinsic value of learning just for the sake of learning, just enjoying the feeling that, "I accomplished something," even if it was tough to start out with.

Senator KLOBUCHAR. Very good.

Dr. GATES. Can I——

Senator KLOBUCHAR. Yes. You all can go, so——

Dr. GATES. Well, as a college professor, of course, it's a little bit different. At our level and mostly by the time we meet students, the real question is, "How do you transition students out of K–12 into university level?" Often, it is the case that they, in their preparation, have seen nothing like what they get when they come to us. And so, for us, we—the biggest thing that you could do to help keep the pipeline open is to make sure that we have a seamless transition, that when we talk about——

Senator KLOBUCHAR. Now, what do you mean by that, exactly? Because that is what I'm talking about here. Because I think there's more and more interest in that——

Dr. GATES. Sure.

Senator KLOBUCHAR.—elementary—we've done a little better job with that.

Dr. GATES. Sure.

Senator KLOBUCHAR. But, how do we keep it going?

Dr. GATES. Yes. Well, the seamlessness would be around—built, in particular, around something—a concept we hear a lot these days, known as "college-ready" and "career-ready." College-ready for the STEM fields means that you have to be able to produce students that can engage the college curriculum without remediation

at high rates. Universities are going to have to play a role in talking through K–12 officials at States' departments of education, and district level about what it means to have expectations for a successful student.

Senator KLOBUCHAR. And you think that the college professors know about the programs, opportunities that are available through STEM?

Dr. GATES. Well, certainly more and more universities are coming to understand that we have to take ownership of this problem. At the University of Maryland, our Chancellor, Brit Kirwan (along with a number of other college/university chancellors and presidents), has agreed to put an increased focus on what the university system does in terms of taking ownership and correcting this fundamental problem and the production of teachers.

Senator KLOBUCHAR. OK.

Dr. MIAOULIS. Curriculum is key for that, too. And, actually, our elementary engineering curriculum—"Engineering is Elementary" is its name—is probably the engineering curriculum used by the majority of elementary schools throughout the world. And actually, Minnesota is one of the biggest users.

And the approach we use for that is the approach of a storybook. We have—the curriculum consists of 20 books. Each book is the story of a child from a different part of the world. And she describes her life, her village, or her city in a challenge or an opportunity that the city or the village had. For example, the little girl from India talks about lack of quality of drinking water in her town and how an environmental engineer built a filtration system and saved the town. And then, the kids, with the teacher, end up building a filtration system in the elementary school, and they become the engineers.

And this curriculum has proven very effective. In particular, the initial research we have done, shows that it closed the gap between poor school districts and rich school districts, because kids from not-wealthy school districts see the whole point of learning science and solving real problems that are relevant to their lives.

Senator KLOBUCHAR. Very good.

And, Mr. Luce, I know you, in your testimony, talked about the UTeach Program with high school retention. Do you want to elaborate on that, or anything else, with how we really make this a much bigger thing in our country, and it will help us, I believe, in the long term?

Mr. LUCE. Well, I would just add one thing. With all the things we talked about, about what we need in elementary school and middle school and innovation in after-school and everything, in our Advanced Placement Incentive and Training Program, we will go—we will increase the number of students in high school who, maybe, didn't have the best middle school training, didn't have the best elementary school training. We're going to have 85,000 students, in high school, who will take an advanced placement course, and pass it, in math and science.

Now, what that says to me is, what we'd better do—let's at least harvest the kids who are not reaching their potential today, because they'll be ready to go to college if they're given an advanced

course and given the opportunity. It's access. It's equity. It's making them career-ready and college-ready.

And we still have low-hanging fruit in high school. If I had my way, we'd have wonderful programs in elementary school and middle school. But, while we're waiting, we'd better not write off another generation, or we're going to fall further behind the Chinese and Indians.

That's all I would add to it, is that there is action we can take today, on a national scale, that will make a difference.

Senator KLOBUCHAR. Thank you very much.

Mr. LUCE. And Minnesota is one of our States.

Senator KLOBUCHAR. Very good.

I love when Texas commends Minnesota. From the Lone Star to the——

Mr. LUCE. Well, I'll tell you——

Senator KLOBUCHAR.—North Star.

Mr. LUCE.—one story. Your Governor——

Senator KLOBUCHAR. Yes.

Mr. LUCE.—pointed proudly to the "10,000 Lakes" license plate and said, "Actually, we have 12,000"——

Senator KLOBUCHAR. Yes, that's true.

Mr. LUCE.—"but we didn't want to brag."

Senator KLOBUCHAR. Yes.

Mr. LUCE. I said, "Well, I'm from Texas. That doesn't bother me, about the bragging."

[Laughter.]

Senator KLOBUCHAR. Well, you know, we're in a little bit of a fight with you over who has the biggest——

Mr. LUCE. Yes.

Senator KLOBUCHAR.—state fair, you know——

Mr. LUCE. I understand.

Senator KLOBUCHAR.—you know, that we really, truly do, but you keep yours open for——

Mr. LUCE. Well, we can agree on education.

Senator KLOBUCHAR.—30 days.

[Laughter.]

Mr. LUCE. Yes.

Senator KLOBUCHAR. OK, thank you. Yes, they're just big, period—Alaska.

All right. Thank you.

The CHAIRMAN. We have moved from STEM to State chauvinism here.

[Laughter.]

Mr. LUCE. The 'S' word.

The CHAIRMAN. I want to ask this question. You know, the ages you referred to who watch you, rather than ESPN or something else—was it 17 to 22, or was it earlier?

Mr. ZASLAV. It started at 12.

The CHAIRMAN. Started at 12 to 22?

Mr. ZASLAV. Yes.

The CHAIRMAN. See, that is such a sensational figure. That is so sensational, because it raises a whole slew of questions, because it means that we, here, and school systems, are underestimating—

clinically, describable through metrics—underestimating their students and what they want to learn.

Now, I raised the question of boards of education. This—anybody can talk on this, and, Ms. Naylor, you don't get to teach, except as you are allowed to teach, right?

Ms. NAYLOR. Well——

The CHAIRMAN. No, I want you to be—this is a direct question, in congressional testimony. I mean, aren't they a problem? They tend to be older, somewhat. And they tend to be more traditional.

Ms. NAYLOR.—they are more traditional. And I don't know about other States, but in West Virginia, it's political. Boards of education are elected. I am required to teach the national standards or the State standards, whichever my State has adopted. And I am required to teach the curriculum that my county has adopted. But, there are times when the door is closed and I can teach things my way and still teach the standards and still use the materials they require. But, I can teach them my way. Fortunately, I have some background that enables me to do that. And all teachers don't.

Dr. GATES. Senator, if——

The CHAIRMAN. Please.

Dr. GATES.—I may respond.

I'm actually a member of my State boards of education in Maryland. We have experience working with the 24 school boards in the state. I can tell you that one of the most encouraging things, to which Ms. Naylor alluded previously, is the common core. At the State level, what has been done (for the first time I've seen in my life) is a sort of awakening to set a standard where a sufficient number of people have come together and said, "Yes, we will sign on to that." It appears to have started the process of creating a rational market wherein you can have a sufficient number of people agreeing on how to do innovation, and provides an environment where it will be done.

The other recent thing I can tell you which the Department of Education has done and that I can see reflected from the State level, is the competition for the Race to the Top funding that the Department has out there now. This competition has done more than I have ever seen before in getting states to concentrate, at least the state level, on improving standards, finding metrics, and enunciating high standards.

So, one of the things for which I commend this body, and the entire government, is for the support that has gone to the Department of Education to support these new State standards. I think Secretary Duncan is doing a marvelous job. And I would hope that that kind of setting of a target that draws states together will continue to be an exercise coming out of this body.

The CHAIRMAN. Thank you, sir.

Let me probe you. Twelve to 22. Now is that among all income levels? Is that rural, urban, rich, poor——

Mr. ZASLAV. It simply——

The CHAIRMAN.—racial——

Mr. ZASLAV.—captures——

The CHAIRMAN.—is it racially divided?

Mr. ZASLAV. It captures kids that are watching television.

The CHAIRMAN. I know it's kids watching television.

Mr. ZASLAV. But, what it really shows is that a good teacher can engage students; quality content that's interesting——

The CHAIRMAN. No, but I'm asking you another question. Are those folks who are picking you over ESPN—which is a glorious decision—do they represent America, as a whole—racially, incomewise, and geographically?

Mr. ZASLAV. It represents a demo of 12- to 22-year-olds all across the country, on a particular night, that are making a choice to watch——

The CHAIRMAN. Have you——

Mr. ZASLAV.—Discovery.

The CHAIRMAN. Have you done any surveys as to whether they come from Latino families, African-American families, rich white families, poor white families in Appalachia or whatever?

Mr. ZASLAV. We can get you some data on it, but Discovery tends to be pretty broad-based. But, we can get you the specific data.

[The information referred to follows:]

Based on Nielsen ratings, the data shows that during the Second Quarter of 2010, the science related programming found on the Discovery Channel outrated the sports programming on ESPN with young boys and men (age 12–22) on 3 nights of the week in primetime—Monday, Wednesday and Sunday nights by 37 percent, 63 percent and 8 percent, respectively. Also from April to present, Discovery Channel outrated ESPN2 in primetime with young boys and men (age 12–22) on Monday, Wednesday and Sunday nights by an amazing 113 percent, 347 percent and 129 percent, respectively.

The programming on Discovery Channel at primetime on other nights of the week is not particularly science related which is why we are providing only the Monday, Wednesday and Sunday data. Given the Chairman's interest in statistics on sports programming vs. science education programming, we wanted you to have the most relevant information.

Clearly there is a demand for science related television from the critical age groups.

The CHAIRMAN. I would really like that, because I've already asked staff to start planning an attack on the cable industry to do more. Because honestly, I have a rather low regard for the cable industry. I think they dumb-down America. On the other hand, you're doing the right thing. You're doing exactly what the good doctor over here wants.

Mr. ZASLAV. Thank you, Mr. Chairman.

The CHAIRMAN.—doable.

Susan, is it doable?

Ms. NAYLOR. It's definitely doable, Senator.

The CHAIRMAN. And does—is it doable only if they have you as a teacher? Is that—that's——

Ms. NAYLOR. No, there are very—there are a lot of dedicated teachers. They just need to be given the professional development to feel confident to use the new materials and the——

The CHAIRMAN. But, where——

Ms. NAYLOR.—new strategies.

The CHAIRMAN.—do you get the professional development? You've got to take time off. Is that a summer activity?

Ms. NAYLOR. Exactly.

The CHAIRMAN. Is that enough to give you—one summer?

Ms. NAYLOR. No, sir.

The CHAIRMAN. How long does it take to get a teacher to that level?

Ms. NAYLOR. It needs to be sustained. It needs to be—a lot of teachers attend webcasts. A lot of teachers go for weekend training. But, the money is not there, Senator. A teacher—you know, in our State, our Governor asked that teachers not be released from classrooms because of snow days. And so, those teachers have to go—if they want extra training, they have to take their own initiative, their own money, their own weekend, and go get it, wherever it happens to be, whether it's in Morgantown or whether it's in Charleston. If it has been advertised and they're interested in it—there was no money this year for very many teachers to go to any national conferences. And that's one very good place for teachers to get it.

Senator BEGICH. Senator——

Ms. NAYLOR. Excuse me.

The CHAIRMAN. Senator Begich, I want you to ask a question.

Ms. NAYLOR. Dr. Payne, in West Virginia, is starting to facilitate professional learning communities within schools, where a whole staff attacks a particular professional issue. And they might do a book study. They might do a webcast. And, to me, that is much more consistent than taking one teacher from Pocahontas County and one teacher from Wood County, and bringing teachers from 40 counties to Charleston. And then they go back and they're still isolated. But, if you bring a whole staff together, and you have them tackle a particular issue—like if they look at the WESTEST scores and they see that there is a weakness in a particular subject area, and they attack what—as a staff, whether they bring in an expert or whether they do a book study or something—then that's effective.

The CHAIRMAN. Because the trick is, is it not—you can—you prove it. The kids want it. Kids—22—you're in college. You're out of college. So, they want it. The kids and the young men and women want it, and we're not supplying it, on the theory that has been demonstrated by some that they're afraid of it, they think they won't do well, or you've got to get a high GPA, or whatever it is.

So, we are underestimating them, and we are mistreating them, in terms of their future. We're giving them an education which deliberately shortchanges what they can do with that education for their own futures.

Mr. LUCE. Senator, we—you have authorized a program that, if you funded, would do exactly what she's talking about. In our Advanced Placement Incentive and Training Program, we go to the school and give them—teachers—coaching and mentoring throughout the year at the school. We give them professional content, professional development. We don't underestimate the students. And we're producing dramatic results. But, the private sector is paying for it in six States, and we have 22 states who are waiting to do exactly what you're asking for. But, you haven't funded it.

The CHAIRMAN. Senator Begich, if you'd indulge me, 30 seconds.

Senator BEGICH. Absolutely.

The CHAIRMAN. Dr. Miaoulis, the—on cable, there are two programs—one called *NCIS,* and one called *CSI New York.* Now, particularly *NCIS*—I ask—I guess I ask this to you all—but, it's all about technology. I mean, unless kids are just Sherlock Holmes

devotees—and I don't think that's necessarily true—I think that they are fascinated by people who just make no decisions without technology—about how fast computers show them—you know, bring up the bad guys and track this and can place where somebody is within any given moment, within seconds. That—I think that qualifies as technology. So, they're showing even—I guess those are CBS things, I'm not even sure—but, they're showing—they're reacting to that for some reason. And I don't think it's the detective nature. So, is that one way they're expressing their interest in something more out of school?

Dr. GATES. Senator Rockefeller, I can respond to that very directly, because we have seen the impact of these television shows on students as they come to college. In fact, what happens is rather interesting. You have students who are fired up, who are enthusiastic, about the idea of learning how to master this kind of technology and science. And when they get to college, they find out that the preparation that they have had in their school does not allow them to do this. And so, although they come with the enthusiasm, when they confront the actual technical requirements to get to where you need to be in order to do that, many of them become discouraged and change direction.

The CHAIRMAN. And, by the way——

Dr. GATES. We've seen this.

The CHAIRMAN.—there's a heavy dose of forensics.

Dr. GATES. Yes. And we've seen this actually go on across universities across the country.

The CHAIRMAN. Yes. Now, I interrupted rudely, as is my custom. Senator Begich.

Senator BEGICH. Mr. Chairman, you have all the rights to do whatever you want. I'm just a pawn in your committee.

[Laughter.]

Senator BEGICH. Now let me ask some questions.

No, I'm just—thank you, Mr. Chairman, for the opportunity.

I want to follow in one area, as I talked a little about rural communities—but, how do you—recognizing, for example, in Anchorage, Alaska, in our school district, we have 94 different languages spoken, one of the highest in the Nation, compared to Chicago and New York and others—and L.A. How do you deliver STEM education training and STEM education with such diverse school districts that are now growing to be more diverse as time goes on? Anyone want to comment on that?

Dr. MIAOULIS. Well——

Senator BEGICH. And the language barriers that do exist, as English may not be their first language at this point in time.

Dr. MIAOULIS. I'll address the diversity issue, not the language issue.

Role models play a big role in motivating children to go in certain areas. So, presenting science and engineering and math in a way that kids could see the big players look like them is very important. And that's why our curriculum is designed to address that. Every single element of the curriculum features a kid that looks different. They're not all white kids. And it has worked very well.

Senator BEGICH. Good. Anyone else want to—on the language issues, or the—go ahead.

Ms. NAYLOR. The new math materials that West Virginia just adopted—and these companies are nationwide, so I assume that they are available in other States, as well—integrate an English language learner component in them so that the teacher is able to facilitate their learning of English as a language in the vocabulary that goes with the math and science lessons that she's teaching. And also, a lot of the DVD supports that are provided are available multilingual.

Dr. GATES. At least near the beginnings of the educational experience, there are some anecdotes. When students are learning basic arithmetic (addition, subtraction, etc.) because the topic is not so tightly bound to language and as long as you have students who are sufficiently fluent in a language, those students do fairly well with, as I said, the basis of mathematics.

Senator BEGICH. Very good.

Let me—Mr. Chairman, I don't have, really, any additional questions. Again, I just want to comment.

I—Mr. Luce, I—you're right. I mean, I can—your comment, I think, at the very beginning was, "The best economic stimulus or economic recovery is education." And let me just make a comment and maybe a question here. For example, we're going to be dealing with a comprehensive energy policy at some point, which is interesting, because part of it's about the new energy economy. There's no education component to the legislation, which I think is a glaring gap, because a lot of that's going to be science, math, technology. And it's great to have a policy about a new economy. But, if you don't have the education component melded into it, it's irrelevant over the long haul, because we will be responding to other countries who will produce the material, as China is proving more and more, especially in renewable energy technology. Is that—that's my analysis. I don't know if—I'm seeing a lot of heads shaking yes, so I think I'm right on this. So, Mr. Luce or anyone else want to——

Mr. LUCE. Well, I would just add, also, it's just so important, in our democracy today, that all of our citizens be what I would call "STEM-capable." They may not go into a STEM career——

Senator BEGICH. Right.

Mr. LUCE.—but they have to be STEM-capable in the 21st century. And that's a huge change in our country and a huge change in our education system. But, we have to address it. If our students aren't STEM-capable, it's not just jobs, it's making basic fundamental decisions in our democracy.

Senator BEGICH. Do you think we need to make sure, in these broader policies, like energy policy or, you know, these larger issues that we deal with—actually, oddly enough, Wall Street reform—you know, one of the things we don't do enough of in school anymore is—I know I had to take it—was personal finance. It has kind of been shoved out the door because we've got to meet all these—I'll be very blunt here—crazy standards that—No Child Left Behind has strangled our school districts. I don't like the legislation, never have, for a variety of reasons. It's a disincentive- versus incentive-driven. But, let me get off of that rant and just say that—is it something we need to kind of change the way we—you know, we're going to do, at some point, I'm assuming, some energy policy

for our country. But, if we're not thinking about the education component—and I can, you know, many major issues like that we're dealing with. And then I'll stop with my questions.

Dr. MIAOULIS. Well, one of my recommendations in my written testimony is to urge Congress to support the President's proposed RE-ENERGYSE education initiative at the Department of Energy, which includes both formal and informal education, so that both schools could introduce curricula related to energy and the science centers could play a role in affecting the general public. And the funding agencies that support research and development in the areas of energy could require that each grant has an outreach component. So, if a university gets a grant to develop a new research program on, let's say, wind energy, they could be required to work with a science center to educate the public around the work they do.

Senator BEGICH. Very good.

Any other last comments, before——

Ms. NAYLOR. There is a move, in education, for teachers to incorporate PBLs, they're problem-based learning, where children are provided a real-world problem, and they solve it, integrating math and science and the other areas. There's a school in my school system that the kids have been challenged—each classroom has been given a certain amount of money to spend for energy for the school year, and they have to decide—they have figured out how much each light costs in their room, how much it costs to run a computer, how much it costs to elevate or reduce the temperature in their room. And when I go in to teach, they have to decide—they have to vote—whether or not they have enough money to turn on the extra electricity to illuminate the board I want to use. And their incentive is, the classroom that saves the most money by the end of the year gets that money to spend on something. And so, these real-world problem-based scenarios are a wonderful way to teach things like energy.

Senator BEGICH. We could have a peer teaching program here. We'll look forward to those students helping us. So, thank you very much.

My time has really expired. But, Mr. Chairman, thank you very much for the opportunity to ask these additional questions.

The CHAIRMAN. No, I think there'll be lots of them.

And you may receive some in the mail, and I hope that you'll answer them.

But, to me, this has been an extraordinarily good, helpful, and potentially far-reaching hearing. And I profoundly thank each and every one of you for what you've done and for what you're doing.

Ms. NAYLOR. Thank you.

Dr. GATES. Thank you.

The CHAIRMAN. Hearing is adjourned.

[Whereupon, at 11:59 a.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO DAVID ZASLAV

Question 1. The President has pledged $3.7 billion for STEM education in the budget, including $1 billion for K–12 STEM education. That funding is spread across many agencies with different cultures and missions. How do you see the Department of Education, NSF and the mission agencies working together to develop a strategy, including basic elements as a common set of metrics for assessing and comparing programs?

Answer. As the leading media provider of science-related programming and education, Discovery applauds this committee and the Administration for working to better educate American students in the fields of science, technology, engineering and math. Excelling in these areas is critical to our Nation's ability to compete at the highest level in an ever-increasingly global economy. To reach this goal, students must have the resources inside and outside the classroom necessary to kindle and maintain a fascination with these critical areas, and Discovery applauds the steps taken by both Congress and the Administration to meet those needs.

Question 2. Are there model programs or approaches to curriculum and instruction that have demonstrated how to increase student achievement and/or teacher performance? What are we investing in? How are these programs evaluated for effectiveness?

Answer. Several states, school systems and education organizations have created effective STEM curriculum and instruction programs. For example, Discovery Education's comprehensive digital science services for elementary and middle level science classrooms are the first digital core instructional materials to be approved for statewide adoption in Oregon. Correlated to the state science curriculum standards and organized around an inquiry-based framework, these digital solutions cover the physical, earth and space, and life sciences, and encourage student exploration, stimulate critical thinking and deepen students' understanding of science. Discovery Education Science also includes a formative assessment tool that provides information on which skills and concepts have been mastered, while directing individual students to remedial activities that address areas in need of improvement.

Discovery Education has partnered with a number of states and districts and has successfully evaluated the impact of our programs on student achievement. For example, Discovery Education partnered with the Charlotte Mecklenburg Schools (CMS) in North Carolina in 2008. This partnership lead to the implementation of a multi-year science curriculum and professional development initiative designed to increase science scores, address needs in reading and math, and provide a more relevant science curriculum to excite and engage teachers and students. The outcome of this collaboration was that CMS students achieved a 44 percent gain in science proficiency on the North Carolina state exams within a 12-month period.

Question 3. Is the curriculum tailored to make sure we're teaching people about current challenges like clean energy problems or other national interests? If so, how are we measuring that this is actually happening?

Answer. Discovery Education offers an array of services that educate students about current domestic challenges. For instance, with the recent Gulf oil spill, Discovery Education immediately responded by offering video resources as well as a nationally attended webinar hosted by Philippe Cousteau, Chief Spokesperson for Environmental Education at Discovery Education. Tens of thousands of teachers and students attended from across the country to hear his first hand account of the immediate effects of the spill.

Other digital curricular resources such as video, virtual labs, science explorations, hands on activities, leveled reading passages, and eBooks to support literacy, are offered through our inquiry-based, Discovery Education Science program. During peak periods, over two million digital lessons and activities that span important top-

ics from science and mathematics, to cultural awareness and the global economy, are delivered to classrooms around the country.

Additionally, Discovery Education works with industry partners to sponsor engagement programs that challenge students to actively participate in making our country a better place for future generations. Thousands of students from all fifty states have participated in programs like the Siemens We Can Change the World Challenge and Discovery Education/3M Young Scientist Challenge. In an effort to better prepare teachers to effectively teach STEM concepts, Discovery Education is hosting a national STEM Academy August 1–6, 2010 where teachers can work with world-renowned scientists and nationally-recognized educators to hone their skills in sparking interest in STEM careers for their students.

Question 4. What else do we need to do? What are the major barriers to improving the interest and performance of K–12 students and teachers in STEM?

Answer. Providing high quality content, generating student interest and motivating students to pursue STEM fields, along with improving teacher knowledge and training, and providing administrative support for effective STEM education, are all crucial to increasing performance of K–12 students and teachers in STEM education. Students need to see real-world applications of STEM. State and local leaders should also provide incentives for teachers to enter the STEM field, particularly when it comes to the representation of minorities and women.

Additionally, there must be vertical alignment of STEM education by improving linkages between secondary education, higher education and the workforce as well as within the Preschool–12 education system. There also needs to be an emphasis on forming strong and effective public-private STEM partnerships among state education agencies, local education agencies, institutions of higher education and the private sector.

Here are a few examples of how Discovery Education is helping students and teachers overcome barriers through the following:

- *STEM Connect*: Offered by Discovery Education, this new curriculum-based and career development science resource is a module designed to fuel teacher and classroom engagement by helping students link science, technology, engineering and mathematics to the real world. Through a collection of rich media educational content, career exploration tools, interactives and hands-on activities, STEM Connect makes science concepts come alive.
- *The Siemens STEM Academy*: Partnering with the Siemens Foundation, Discovery Education created a national STEM education program for teachers. Designed to support educators in their efforts to foster student achievement in STEM, the program includes the first online shared repository of STEM best teaching practices, a National Teacher Academy bringing together science educators from across the country, and an ongoing webinar series featuring leading scientists and experts in their fields.

Question 5. How can partnerships between various stakeholders in the STEM education system facilitate the identification and implementation of successful models?

Answer. Discovery supports public-private partnerships and is uniquely qualified to support schools through Discovery Education, the top provider of digital content to schools. For example, Discovery Education Science is designed for elementary and middle school science classrooms and correlated to state science curriculum standards. This service fits perfectly with the Department of Energy's pilot grant program for statewide secondary schools specializing in science. These types of synergies between the government and private sector will enable schools to improve student achievement.

Response to Written Questions Submitted by Hon. Mark Warner to Ms. Susan Naylor

Question 1. The President has pledged $3.7 billion for STEM education in the budget, including $1 billion for K–12 STEM education. That funding is spread across many agencies with different cultures and missions. How do you see the Department of Education, NSF and the mission agencies working together to develop a strategy, including basic elements as a common set of metrics for assessing and comparing programs?

Answer. I would recommend that any funding application process be developed with teacher input. Most teachers can see beyond their own backyards to the bigger picture of what is best for the most students, regardless of the different culture and mission being addressed. Teachers have the best understanding of what would be

realistically effective in schools and classrooms, and a true sense of what teachers would need to implement any proposed programs.

Question 2. Are there model programs or approaches to curriculum and instruction that have demonstrated how to increase student achievement and/or teacher performance?

Answer. The nationwide movement from traditional textbook, "stand and deliver" instruction to the more 21st century-appropriate "inquiry" student involvement programs of instruction has much research to support its impressive impact on student achievement and also on the professional development of teachers implementing the materials and strategies. The TERC "Investigations", (*http://investigations.terc.edu*) elementary mathematics curriculum, currently being distributed through Pearson publishers is one that I have witnessed first hand to have the impact you are asking about. Also the "Everyday Mathematics" program, born from the University of Chicago School Mathematics Project has a great deal of research supporting it.(*http://everydaymath.uchicago.edu*) I'm sorry that my field is limited to citing elementary mathematics programs, I am sure teachers in the other STEM fields could refer you to equally impressive programs in their areas.

Question 2a. What are we investing in?

Answer. I have witnessed us, as a country, investing in 50 different directions based on 50 different state standards and instructional objectives. Although I appreciate the needs of individual states, the redundancy of work and cost has been a sad waste of resources. I am very optimistic about the CORE CURRICULUM. As the population of our country becomes more and more mobile, students (and teachers) will benefit from the consistency. There will be more harmony in educational pedagogy, instructional materials, appropriate assessment and staff development.

Question 3. How are these programs evaluated for effectiveness? Is the curriculum tailored to make sure we're teaching people about current challenges like clean energy problems or other national interests?

Answer. In many states, curriculums are being enriched with PBLs (Project Based Learning)—units of study developed around real world problems and timely issues. Through these PBLs, students uncover what they need to know in order to address the challenge presented to them. They become their own teachers, with the classroom teacher serving as the facilitator and mentor. The West Virginia Department of Education has built an impressive library of teacher designed PBLs for grade levels K–12 and across many curricular areas which is available on their Teach 21 website: *http://wvde.state.wv.us/teach21/pbl.html*.

Question 3a. If so, how are we measuring that this is actually happening?

Answer. Teachers report high levels of student engagement and deeper conceptual understanding of targeted skills and content. Most PBLs include a variety of assessments that can be used to measure student achievement as the project progresses. I don't know of any standardized measurement of student achievement that can isolate data to specifically measure the effectiveness of PBLs, but I recommend the Buck Institute for Education websites if you would like more information (*www.bie.org* and *pbl-online.org*)

Question 4. What else do we need to do? What are the major barriers to improving the interest and performance of K–12 students and teachers in STEM?

Answer. The teachers I work with, both locally, at my state level and at national levels unanimously cite teacher education as the major barrier to improving interest and performance of students and teachers in the STEM areas. We are desperate for high quality, content specific and sustainable staff development. Teachers are so accustomed to the "flavor of the day" staff development, that they have developed an expectation that before long another train will come down the track and the current one will be abandoned, so they don't invest much of themselves in the trainings and certainly don't expect them to make much of a difference. Teachers have not had the support, especially in their own classrooms, to sustain any significant change in practice even if they are persuaded to try it. Teachers also need avenues to connect with peers; many are isolated by scheduling issues and never have opportunities to build collaborative professional relationships with other teachers which could support the change we advocate.

Question 5. How can partnerships between various stakeholders in the STEM education system facilitate the identification and implementation of successful models?

Answer. I would hesitate to identify successful models on research alone, teachers who are actually teaching from a specific curriculum can offer a great deal of information regarding its impact on their own students, their ability to implement the components of the programs, and how effective the program's assessments and sub-

sequent interventions are for promoting achievement. I also suggest that students in secondary classrooms, as stakeholders who have the ability to express their opinions, should be included in identification of models that were successful for them.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO DR. S. JAMES GATES, JR.

Thank you for the questions following my appearance before the Senate Commerce Committee and the opportunity to respond to them. Before I respond, let me state I am not speaking on behalf of any group, institution, or organization to which I belong nor with which I am affiliated. My responses are personal, but informed by my experience in higher education, as a research scientist, and as someone involved in policy formation over the last twenty-five years.

Question 1. To date, what are the most promising efforts to attract and retain women and minorities in STEM fields?

Answer. In response to your first question, there are two rather distinct states of rate participation playing out.

Regarding women, although their participation of in our Nation's STEM disciplines still lags, there continues to be an observable improvement in the rates. The improvement varies across disciplinary fields. For example, my own area of physics is generally found to have among the lowest rate of participation by female scientists. Biology has a higher rate of participation. In addition there continues to be noticeable differences in awarding academic rank; the rate of promotion for women to assistant, associate, and full professor vary widely across all universities and colleges including our most elite ones. A similar situation seems to prevail at national laboratories. But the overall picture is one of improvement; it is painfully slow, but it is improvement.

Regarding minorities, participation rates in STEM fields are approximately 4–7 percent with little, if any, detectable trends toward substantial improvement.

Unfortunately, I know of no generally accepted metrics that allow me to tell which efforts have performed best.

Question 2. What can be done to assure that there is sufficient support, mentoring, etc. so that our economy will benefit from their future contributions?

Answer. This is a difficult question for me to answer. Although one might argue about the depth or quality of past efforts in this direction, the fact remains efforts have been and continue to be made. Some of these efforts have improved the rates of female participation in different STEM fields. I believe for this progress to be sustained, current evidence suggests maintenance of policy and practice already in place will yield continued results, albeit slow ones. To increase minority participation in STEM disciplines, in my opinion, the most effective investment would be to attack the lack of access to high quality teaching of STEM areas in the K–12 school systems, especially in large urban areas with regard to the African-Americans and Hispanic-Americans, reservations with regard to Native American, and rural areas for American away from our large cities. I believe that one other way to attack this problem is to ensure that schools have state-of-the-art broadband Internet coupled with policies and practices that allow students and teachers the opportunity to utilize such access.

Question 3. What efforts have been successful in attracting Native American students in Tribal schools to succeed in STEM fields?

Answer. I have seen at least one focused thrust result in greater involvement in STEM fields among Native American students in Tribal schools. Let me give an example of a successful program. I served on the board of the organization Quality Education for Minorities Network (QEM) based in Washington, DC. For over a decade, QEM operated programs (with a STEM focus) in tribal schools across the U.S. that increased STEM educational engagement. The key elements of the QEM effort included: (a) workshops at Tribal school by visiting scholars, (b) readily available Internet access, and (c) professional development seminars for tribal school teachers.

Question 4. Do you have any specific recommendations for encouraging women and minorities to take advantage of STEM career opportunities with the Federal agencies that this committee oversees?

Answer. When I was Chairman of the Physics Department at Howard University, I made an effort to ensure that students had access to high quality summer jobs and internships at national laboratories (Department of Energy, National Aeronautics and Space Administration, etc.). Many such programs existed in the early nineties. I am still a believer that such programs can make a difference.

However, stringent attention must be paid to design and effectiveness of these programs. In some poorly designed programs students were given rote work, and not integrated into laboratory staff or actual research. I believe such programs would ideally require students to become involved in data collection, collation, and analysis in high-priority laboratory projects. Those responsible for these programs must have the scientific credentials to lead. Outreach/equity officer members of laboratory staffs did not provide the required leadership. The operation of such programs without aggressive monitoring and oversight by scientists does not appear to be a good investment.

Again, as Chairman of the Physics Department, I worked to facilitate the engagement of the Howard University physics department with programs at national laboratories by involving undergraduate students, graduate students and faculty in collaborations with scientists at major institutions to actively pursue research. In some laboratories, particularly Department of Energy laboratories, laboratory managers were actively resistant to this partnership. At a minimum, I believe the U.S. Government should create policies that promote the active engagement of national laboratories with historically black colleges and universities, minority serving institutions, and tribal colleges. Thus, it might be a useful exercise for U.S. Government supported laboratories to collect outcome-based statistics so policymakers can actively monitor their performance in this area.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO DR. S. JAMES GATES, JR.

Thank you for the questions following my appearance before the Senate Commerce Committee and the opportunity to respond to them. Before I respond, let me state I am not speaking on behalf of any group, institution, or organization to which I belong nor with which I am affiliated. My responses are personal, but informed by my experience in higher education, as a research scientist, and as someone involved in policy formation over the last twenty-five years.

Question 1. The President has pledged $3.7 billion for STEM education in the budget, including $1 billion for K–12 STEM education. That funding is spread across many agencies with different cultures and missions. How do you see the Department of Education, NSF and the mission agencies working together to develop a strategy, including basic elements as a common set of metrics for assessing and comparing programs?

Answer. As a scientist and university educator whose work has been funded by the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and who has served in various advisory capacities with the Department of Energy, and the National Science Foundation, I have over 25 years experience observing some of the science mission agencies make efforts in this area. I have had very little experience with the Department of Education. This dichotomy is representative of a part of the problem.

Currently, the various agencies of the U.S. Government have an array of programs to assist the Nation with the STEM education challenge. I do not have to emphasize the link between the current shortfall in the national performance in these areas as measured by international metrics and the threat this poses the economic future of the United States. I believe a more vigorous strategic approach to the expenditure of efforts and resources would greatly benefit the effectiveness of the programs of known to me. My own observations, though purely anecdotal, support the view that more precise metrics and assessments are vitally needed to maximize the return on government expenditures.

I believe that a more vigorous and comprehensive integration of programs between the Department of Education and the science mission agencies of the U.S. Government focused in the area of STEM education ought to be considered. But no broad brush one-size-fits-all approach will work.

Question 2. Are there model programs or approaches to curriculum and instruction that have demonstrated how to increase student achievement and/or teacher performance? What are we investing in? How are these programs evaluated for effectiveness?

Answer. As an individual scientist and educator, I have come across some small number of programs that seem to accomplish the goals of increased student achievement and/or teacher performance. However, such programs often seem to be a "one-off" whose existence is not widely known or duplicated. As a result, though there appears to be substantial investment aimed at the goals you indicate in your question, it is extremely difficult to know what the current investments are. As a practical matter, there is a great need for some centralized mechanism for at least an

inventory of such investments. There is also a need for standardization of assessment so that effectiveness can be measured and compared.

Question 3. Is the curriculum tailored to make sure we're teaching people about current challenges like clean energy problems or other national interests? If so, how are we measuring that this is actually happening?

Answer. We are confronted by an extremely fractured system. The extreme divides between wealth and poverty, access to modern computer-based communication networks, urban versus rural communities, distinctions in community values, etc. make it impossible to provide a comprehensive answer. For some students in some situations there is excellent curriculum material preparing the next generation to face these problems. Some great examples exist. Agencies such as the National Oceanic and Atmospheric Administration (NOAA) and NASA have already provided online access to data sets taken from the real world and packaged so that these can become modules in curriculum materials. The second part of your question concerns measuring what is happening. I cannot report much optimism. The lack of the ability to assess effectiveness is an over-arching problem across all STEM disciplines.

Question 4. What else do we need to do? What are the major barriers to improving the interest and performance of K–12 students and teachers in STEM?

Answer. You have raised the question of what else can be done. I believe the answer to this is beginning to emerge. Let me give one example. There has recently emerged a state-led effort to establish a common core of standards in language arts and mathematics. This is an important national accomplishment and a model for how a grass-roots approach is capable of attacking a national problem. The U.S. Government should position itself to effectively support such future efforts. The so-called "digital divide," especially with respect to state-of-the-art communication, technology still exists. As our Nation created the national highway system during the 50s and 60s, the creation of a state-of-the-art electronic equivalent today is an important challenge. A part of this must include the most efficient management of the electromagnetic spectrum.

Question 5. How can partnerships between various stakeholders in the STEM education system facilitate the identification and implementation of successful models?

Answer. It is my opinion that the STEM community itself has a responsibility to look deeply at its ethos, practices, and values in view of asking a simple question: How can we be more effective in discharging our duty to the Nation in opening our disciplines to all Americans who have the ability to contribute? Continuing as we (the STEM community) are today is a prescription for a continuation of young Americans opting not to pursue these areas vital to the long-term interest of the country. A possible way such partnerships might unfold would be to create incentives for STEM researchers to increase their engagement in the education of younger citizens. However, any such attempts must be tied to assessment of their effectiveness. Not all scientists are capable of well nor effectively engaging this duty on behalf of STEM fields.

Due to the lack relations between educators and scientific researchers, the creation of partnerships appears to be one of the best options for reaching President Obama's goal of moving U.S. student performance "to the top of the pack" in international assessments. Such partnerships must occur between:

- Teachers and local and state-level education officials
- State-level educational officials across state boundaries
- Public entities with private/commercial entities
- Local and state-level educational officials with national educational officials

The Federal Government needs better coordination across its various agencies for effective engagement to reach national goals and to cooperate with state-led initiatives in leveraging benefits from the Department of Education as well as the science mission agencies.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO DR. IOANNIS MIAOULIS

Question 1. Attracting and retaining more women and minorities in STEM related career fields continues to be a challenge. According to a recent Department of Labor report, women are underpaid and underrepresented in STEM occupations as compared to men. The National Science Foundation reported that women earn only 21 percent of doctoral degrees in computer science. Moreover, many women who earn science, engineering, and math degrees are not hired in STEM fields.

Research from the American Association of University Women suggests that this disparity threatens our ability to innovate and compete globally in these fields. I see this as both a pipeline issue for developing new talent, and also a hiring and retention issue. To date, what are the most promising efforts to attract and retain women and minorities in STEM fields?

Answer. At the professional level there are a numerous professional societies for women and minorities in STEM fields that conduct outreach programs and provide continuing education, advocacy, and mentoring services. Some of these organizations also have collegial and high school chapters. These all are self-selecting efforts. We believe to broaden and diversify the STEM workforce pipeline, we must engage ALL students, in elementary and secondary schools, in real-world engineering design challenges that provide relevance and rigor in STEM content areas. Our curricular materials have a strong emphasis on diversity featuring male and female engineers from around the globe with varying abilities. With respect to retention, family friendly work policies are needed across the board to attract and retain talent.

Question 2. What can be done to assure that there is sufficient support, mentoring, etc. so that our economy will benefit from their future contributions?

Answer. Corporations should be encouraged to support employee membership in professional societies and continuing education for their employees. In schools, trained STEM resource teachers are needed to support the interdisciplinary approach necessary for effective STEM instruction—allowing math and science teachers to collaborate with technology and engineering educators to work on engineering design challenges—real world challenges that provide relevancy to students.

Question 3. What efforts have been successful in attracting Native American students in Tribal schools to succeed in STEM fields?

Answer. We do not have a lot of experience in these schools yet. The design challenges embedded in our engineering curricula were selected and designed to provide relevancy to students' lives and appeal to a diverse student population. One of our latest Engineering is Elementary units is entitled, "Tehya's Pollution Solution," featuring a young Native American girl who discovers an oil spill and engineers a plan to clean it up. Another new unit features Despina, a child in a wheelchair, who loves to swim and learns to design an submersible ocean vessel to retrieve her lost goggles. Salila rescues a turtle from a polluted river, Leif harnesses the wind to do work, Lerato learns about insulation while designing a solar oven . . . all units can be previewed at *www.mos.org/eie.* When you use diverse role models and challenges that are relevant to their culture and community, then you can attract a diverse population.

Our research shows that EiE students are performing better than the control groups in technology, engineering and science. We estimate that over 1.2 million children and 15,000 teachers have been exposed to this curriculum. Colorado Springs, in fact, is one of our field test sites. We would be happy to have Senator Udall visit such a classroom.

Question 4. Do you have any specific recommendations for encouraging women and minorities to take advantage of STEM career opportunities with the Federal agencies that this Committee oversees?

Answer. A greater financial commitment to federally-funded, higher education fellowships, internships, scholarships would undoubtedly attract more candidates to Federal service. Perhaps programs like Teach for America could be developed to Work for America.

NASA recently issued a report you may be find helpful: "Title IX for Science, Technology, & Engineering, & Mathematics." *http://odeo.hq.nasa.gov/documents/71900__HI-RES.8–4–09.pdf.*

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO DR. IOANNIS MIAOULIS

Question 1. The President has pledged $3.7 billion for STEM education in the budget, including $1 billion for K–12 STEM education. That funding is spread across many agencies with different cultures and missions. How do you see the Department of Education, NSF and the mission agencies working together to develop a strategy, including basic elements as a common set of metrics for assessing and comparing programs?

Answer. A system is needed that encourages collaboration and economies of size to create comprehensive education outreach programs that can be stretched to reach more expansive audiences. The STEM Coordination Act should help in developing this system. Each science agency should have a robust education budget that en-

ables them to work effectively in both formal and informal education arenas. Each agency should make every effort to collaborate with existing formal education systems (teacher prep programs, curricula & assessment developers, professional development outlets, etc.) and informal science education institutions that have deep community connections and outreach systems in place.

Question 2. Are there model programs or approaches to curriculum and instruction that have demonstrated how to increase student achievement and/or teacher performance? What are we investing in? How are these programs evaluated for effectiveness?

Answer. Our *Engineering is Elementary* curricula series, funded by the National Science Foundation, aligns with popular science topics taught in elementary grades. We are partnering with other science centers, community colleges and universities to provide the requisite teacher professional development to teach the engineering design process. We have published several research papers detailing both teacher and student learning. Visit *www.mos.org/eie*.

Question 3. Is the curriculum tailored to make sure we're teaching people about current challenges like clean energy problems or other national interests? If so, how are we measuring that this is actually happening?

Answer. Our design challenges embedded in our engineering curricula were selected and designed to provide relevancy to students' lives and appeal to a diverse student population. One of our latest Engineering is Elementary units is entitled, "Tehya' Pollution Solution," featuring a young Native American girl who discovers an oil spill and engineers a plan to clean it up. Another new unit features Despina, a child in a wheelchair, who loves to swim and learns to design an submersible ocean vessel to retrieve her lost goggles. Salila rescues a turtle from a polluted river, Leif harnesses the wind to do work, Lerato learns about insulation while designing a solar oven . . . all units can be previewed at *www.mos.org/eie.* Our research shows that EiE students are performing better than the control groups in technology, engineering and science. We estimate that over 1.2 million children and 15,000 teachers have been exposed to this curriculum. Arlington Science Focus School was an early adopter of our curricula. We would be happy to have Senator Warner visit a classroom there.

Question 4. What else do we need to do? What are the major barriers to improving the interest and performance of K–12 students and teachers in STEM?

Answer. Students need exposure in schools to the human made world. They are digital natives that should know that technology is more than Xbox, iPods and cell phones. While these are intriguing technologies, they cannot solve all of our problems. A greater understanding of all things human-made will give students greater options and ideas about career paths.

For teachers, understanding that engineering design is a pedagogical method, like the scientific inquiry process, that will engage students in research, planning, designing, prototyping, building and testing new technologies, providing relevance via real world problems. Professional development and tested instructional materials are necessary components for success.

Question 5. How can partnerships between various stakeholders in the STEM education system facilitate the identification and implementation of successful models?

Answer. In addition to research and development investments, a greater focus is necessary on broader impacts and public outreach. University researchers must partner with community organizations, such as science centers, to communicate their new discoveries to the public at large and especially teacher and students. Science museums regularly provide teacher professional development in a very accessible and affordable environment. Nationwide networks can be established to replicate best practices, transferring knowledge from larger to smaller facilities that may have fewer resources for research and development. A terrific example of this is the Nanoscale Informal Science Education Network *www.NISEnet.org*.