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S. HRG. 109–393

PROTECTING AMERICA'S COMPETITIVE EDGE ACT (S. 2198): HELPING K–12 STUDENTS LEARN MATH AND SCIENCE BETTER

HEARING

BEFORE THE

SUBCOMMITTEE ON EDUCATION AND EARLY CHILDHOOD DEVELOPMENT

OF THE

COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS
UNITED STATES SENATE

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

ON

EXAMINING S. 2198, TO ENSURE THE UNITED STATES SUCCESSFULLY COMPETES IN THE 21st CENTURY GLOBAL ECONOMY, FOCUSING ON EFFORTS TO IMPROVE MATH AND SCIENCE AND TECHNOLOGY EDUCATION

MARCH 1, 2006

Printed for the use of the Committee on Health, Education, Labor, and Pensions

U.S. GOVERNMENT PRINTING OFFICE

26–426 PDF WASHINGTON : 2006

For sale by the Superintendent of Documents, U.S. Government Printing Office
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PROTECTING AMERICA'S COMPETITIVE EDGE ACT (S. 2198): HELPING K–12 STUDENTS LEARN MATH AND SCIENCE BETTER

WEDNESDAY, MARCH 1, 2006

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION AND EARLY CHILDHOOD DEVELOPMENT, COMMITTEE ON HEALTH, EDUCATION, LABOR AND PENSIONS,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:10 a.m., in room SD–430, Dirksen Senate Office Building, Hon. Lamar Alexander (Chairman of the Subcommittee) presiding.

Present: Senators Alexander, Burr, Ensign, Dodd, Bingaman, Kennedy, and Jeffords.

OPENING STATEMENT OF SENATOR ALEXANDER

Senator ALEXANDER. Good morning. Excuse me for being a little late. The Senate, in its usual burst of efficiency, delayed the vote, and we were trying to figure out how to have the hearing with the least inconvenience to the witnesses. Today's hearing will come to order. This is the Subcommittee on Education and Early Childhood Development. We do have a vote that has started, but rather than delay things, we will go ahead and begin the hearing, and then when Senator Bingaman or Senator Isakson or other Senators come, I will turn the Chair over to them, I will run over and vote, come back, and then we will go ahead.

We will go in our usual order with the administration witnesses on the first panel, and then the other witnesses. If it is all right with the witnesses, I am going to invite Governor Hunt to come up right after Mr. Bement and Dr. Johnson because he needs to leave by 11 o'clock, and that will give him a chance to testify. We may have a question or two for him, and then he can be excused, and then we will go back to the administration witnesses. So that we will follow procedure.

This is the second in a series of two hearings by this subcommittee on the education provisions of the act we call "Protecting America's Competitive Edge." Another way of talking about it would be to say that this is the act that incorporates the 20 recommendations of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine in answer to the question from a number of Senators: How do we keep our edge in science and technology over the next 10 years in a more competitive world?

I want to acknowledge and thank the administration for its cooperation in the development of this legislation. We had extensive homework sessions, which Dr. Bement and others attended. The Academy Committee, led by Norm Augustine, basically gave up their summers and reviewed hundreds of various proposals before coming up with their 20 recommendations. And I think because of that extensive amount of work and because of the interest among Senators on both sides of the aisle for a number of years in this general subject, we have developed a consensus document. It may not be the whole answer. It may be amended as it goes. We have 67 cosponsors of the PACE Act, the Protecting America's Competitive Edge Act, which is the 20 recommendations, some with subparts, from the Academies. And it is beginning to make its way through the Senate.

Senator Domenici, on the Energy Committee and Senator Bingaman, who are the principal sponsors of the whole act, held hearings on the eight provisions that are in the Energy Committee. Yesterday we held a hearing in this subcommittee on five more of the provisions which have to do with kindergarten through the 12th grade teachers.

Today, we are focusing on students in kindergarten through the 12th grade, specifically four provisions that would, first, increase the number of students who attend advanced placement courses; second, provide grants to States to establish high schools that specialize in math and science; third, provide opportunities for middle and high school students to have internships at national laboratories or at universities; and, fourth, create a clearinghouse of math and science materials.

Not only do we have a consensus document and 67 cosponsors, we have a President who put this item high on the agenda, as only a President can, in his State of the Union address and some significant dollars in the budget that we are considering.

The goal of those of us who sponsored this legislation is to pass all 20 of the recommendations with improvements, as they are suggested by other members of the Senate, and to fully fund it, which comes to an $8 or $9 billion figure in the first year, with about half of that making permanent the research and development tax credit.

So that is a tall order, but if the question is what do we need to do to keep our advantage in science and technology in order to keep our jobs from going to China, continue to fight the war on terror, to have energy independence, and to innovate our way out of the health care crisis, then it seems to me that we ought to try to do all of the recommendations, not just half of them.

At this point we will include in the record the statement of Senator Enzi, Chairman of the full committee. I would also like to include the statement of Senator Ensign.

[The prepared statement of Senator Enzi follows:]

PREPARED STATEMENT OF SENATOR ENZI

Thank you, Mr. Chairman, for holding this second in a series of hearings on competitiveness. It is good to have another distinguished panel of experts with us today to help inform our work on this important issue.

Yesterday's hearing gave us all an opportunity to focus on the role our Nation's teachers will play in preparing our children to meet the challenges they will face when the time comes for them to take their place in the workforce of tomorrow. We heard from a number of experts who have had a great deal of success in the effort to provide the training our math and science teachers will need if they are to keep their classroom skills current and get their students excited about learning. That will be a key part of the work that must be done to ensure our students are the best in the world and they receive the training in math and science we will need as a Nation if we are to continue to be a leader in the world's marketplace.

Today's hearing will focus on the same question, this time from the perspective of our Nation's students and their classroom environment. We will have a chance today to look at ways we can encourage and promote the natural curiosity our children have about fields like math, science, engineering, health, technology and the foreign languages we must master to ensure our ability to communicate, correspond and understand the advances that are being made in other countries in these important subjects.

Over the past 10 years, this country has paid significant attention to math and science education, and some reports suggest we're on the right track. According to the 2003 Trends in International Math and Science Study (TIMSS), 8th graders in this country ranked 15th in math achievement among the 45 participating Nations. In science education, American 8th graders ranked 9th. In both instances, those rankings were an improvement from the 1995 study.

We still have a lot of ground to cover. The TIMSS study points out that for the period from 1995 to 2003, 4th graders in this country did not improve their standing in math achievement, and 4th grade science achievement actually declined relative to other Nations. Other studies, such as the PISA 2003 study, rank the United States even lower in math and science skills, behind 25 other Nations.

Most studies, however, identify the same challenge for our country. The Nations leading in math and science achievement are quickly becoming our biggest competitors in the international economy. Korea, Hong Kong and Japan continue to outperform the United States on math and science achievement in most studies, as do many Nations in Europe.

Congress took important steps to help improve our math and science education achievement when we passed the bipartisan No Child Left Behind Act. Achievement has improved, and the accountability embraced by that legislation is paying off. Teachers, principals and school support staff are making an effort to reduce the achievement gap, and it's working. In Wyoming, for example, reading and writing achievement has improved statewide and the State high-school completion rate is 81.5 percent, among the highest in the country.

We are at a point where policymakers need to look at the next step, and figure out how to support an education system that will improve math and science outcomes into the future. Our ability to

develop strong foundations now will pay off for years to come as we face stronger competition globally.

Last month, we heard from Secretary of Education Margaret Spellings on the role of education in meeting the challenges of global competitiveness. This committee also hosted a roundtable discussion on high school success, where participants talked to us about building and filling the pipeline so more high school students graduate on time prepared for postsecondary education and the workplace, and not in need of further remediation.

One such idea is the expansion of Advanced Placement and International Baccalaureate programs. In Wyoming, we've seen an almost 17 percent increase in the number of students enrolled in AP courses, and a 16.3 percent increase in the number of students taking AP tests.

We look forward to hearing today from experts who will share a variety of perspectives with us. Your insights will be an invaluable addition to our understanding of how to improve our students' abilities and their achievements in math and science. I hope you realize how much we appreciate and value your attendance and participation.

I look forward to continuing to work on these issues with my colleagues on this committee, so that we might find new and better ways to incorporate the concepts we will learn during these hearings into a legislative strategy that will ensure our long-term competitiveness in the world marketplace for generations to come.

[The prepared statement of Senator Ensign follows:]

PREPARED STATEMENT OF SENATOR ENSIGN

I would like to take this opportunity to thank Senator Alexander for holding a hearing on math and science education. The past 2 years have seen an unprecedented amount of activity and interest in math and science education. First was the unveiling of the National Innovation Initiative by the Council on Competitiveness. Following that, the National Academies of Science released a report titled "Rising Above the Gathering Storm." Each of these reports lists specific recommendations to Congress that are designed to increase the competitiveness and innovativeness of the United States.

These reports have elicited numerous legislative proposals. Senator Lieberman and I introduced the National Innovation Act in response to the National Innovation Initiative. Senators Alexander, Bingaman, and others introduced three different bills that make up the Protecting America's Competitive Edge, or PACE, Acts. These proposals offer a myriad of solutions to help better prepare our Nation's students in math and science education.

This country has a long-standing history of being one of the most inventive and innovative countries in the world. We have also fostered competition and attracted scientists, engineers and mathematicians from across the world. However, I feel that we are losing that competitive edge.

The purpose of today's hearing is to review math and science education and determine what can be done to truly protect our competitive edge. It is my belief that we must first take stock of what we have. The Government Accountability Office took the first

big step with their report on Federal science, technology, engineering, and mathematics (STEM) programs. This report found that the Federal Government supports over 207 STEM-related programs. Unfortunately, this report did not include programs funded within the Department of Defense. I hope to work with Secretary Rumsfeld to get a good account of the programs that DOD is currently supporting.

It is absolutely vital that not only each of us work together, but that each Federal Agency work together as well. I believe that Dr. Bement said it right in his testimony: "even the most innovative programs, however, will not result in improving STEM achievement unless we find ways to scale them up and remove impediments to their broad adoption." We need to focus our efforts and work with each of the agencies that support STEM programs to see how they can hold each other accountable and produce the most effective results.

In reviewing the PACE legislation that has been introduced by Senators Alexander and Bingaman I can say that I am supportive of many of the concepts that are embedded within the legislation. It is vital that we get better qualified math and science teachers in the classroom, we must work to get students excited about taking math and science courses, we must work to expand Advanced Placement (AP) programs, and we must find a way to get research-based, effective curriculum into the hands of teachers. However, I disagree with the manner in which the PACE bills realizes these concepts.

First, I believe that math and science related programs need to be housed and supported in agencies that have proven track records in providing effective math and science education programs, both for teachers and students. The Department of Education and the National Science Foundation have strong track records and are eager to be held accountable for the programs they have. It is unnecessary and unwise to spread these programs across agencies that do not have the expertise or know-how to get into a classroom and really help our teachers and students. I would rather have agencies like the Department of Energy do what they know best, and that is to develop and implement effective energy policy for this country.

Second, it is vital that we take stock and learn more about each of the programs that the Federal Government currently funds before moving forward with comprehensive legislation. It would be unfair to us and to taxpayers if we create programs that are only duplicating efforts found elsewhere. There are numerous Federal programs that have proven track records and are similar in purpose to those proposed by the PACE legislation. A thorough review of these programs needs to be completed to determine where we need to go next. I am hopeful that this review will also uncover programs that have outgrown their original purpose and no longer serve a national need. If such programs are found, then they need to be terminated and their funding reallocated to other STEM-related programs.

Third, it will be necessary to create some new Federal programs. It is important that these programs be crafted to compliment ongoing action in States, local school districts, and the private sector.

It is clear from the testimony provided to this subcommittee that States, universities, school districts, and the private sector have created programs to meet the needs of students and teachers in the STEM fields. Congress must ensure that we do not hamper these efforts, but enhance them. It may be necessary to provide seed money, especially for some of the new teacher training programs that are proposed in PACE. But, I fail to see a compelling policy reason for the Federal Government to support these programs indefinitely. As Dr. Rankin said in yesterday's hearing, universities and departments need to find ways to include these new programs in their budget to support ongoing activities.

Finally, it is absolutely imperative that we include metrics for current programs and any new program we create. Effective metrics are the only way for Congress and the public to know how these programs are performing and if they are fulfilling their purpose. Programs must be required to report exactly what they are doing, how well they are performing, and long-term effects of their program.

Mr. Chairman, as this committee moves forward in its efforts to increase competitiveness, I hope that it will endorse the best parts of all the bills that have been introduced. Senator Lieberman and I introduced provisions in our bill that will promote and accelerate research and development on innovative projects. Also included in this legislation is a renewed commitment to better fund basic research at the National Science Foundation (NSF). Provisions are included that will increase regional economic development activity and advanced manufacturing systems. The legislation also includes a provision that would permanently extend the research tax credit for companies engaging in long-term research projects.

We took a narrow approach when it came to education issues as well. We increased the number of graduate fellowships and traineeships at NSF. We also authorized funds to expand Professional Science Masters Degree programs at universities across the country. The Tech Talent expansion program is bolstered in this legislation, as is innovation-based experiential learning. Also enhanced is the Department of Defense's Science Mathematics and Research for Transformation (SMART) scholarship program.

The National Innovation Act took a very narrow approach. We were careful to look for effective programs that are already funded by the Federal Government and found ways to expand them. The legislation also looked outside of the structure of the Federal Government to assist the private sector in engaging in important research, especially high-risk, high-payoff research.

Again, I thank Senator Alexander for his leadership on these important issues and look forward to working with him in the future. I believe that in working together we can find solutions that will work best for our country and will truly keep the United States competitive.

Senator ALEXANDER. We have a distinguished panel of witnesses to testify. Assistant Secretary Henry Johnson from the Department of Education is one of the two administration witnesses. I hope in addition to commenting on the PACE Act, he will also compare it to the provisions in the President's American Competitiveness Initiative.

Dr. Arden Bement, Director of the National Science Foundation, is here. He has broad experience in a great many of the areas we are talking about. Dr. Bement, one of the things we especially want to consider is whether we are duplicating programs: whether you are already doing some things, and other parts of the Federal Government are doing some things. These are very good and well-thought-out recommendations, and we will be interested, especially in your comments about whether we ought to build on or amend some things we are already doing, or whether there needs to be some new initiatives.

I will introduce the second panel when we get to it, but for now, I think the best thing to do is to begin first with Dr. Johnson, then go to Dr. Bement. I have a little machine here that goes for 5 minutes. I would appreciate your trying to summarize your comments within 5 minutes, which will give the Senators time to ask you questions.

STATEMENTS OF HENRY JOHNSON, ASSISTANT SECRETARY, OFFICE OF ELEMENTARY AND SECONDARY EDUCATION, U.S. DEPARTMENT OF EDUCATION, WASHINGTON, DC.; ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION, WASHINGTON, DC.; AND JAMES B. HUNT, FORMER GOVERNOR OF NORTH CAROLINA, AND CHAIRMAN, JAMES B. HUNT, JR. INSTITUTE FOR EDUCATIONAL LEADERSHIP AND POLICY, CHAPEL HILL, NC

Mr. JOHNSON. Thank you, Chairman Alexander. Is this on? Can you hear me?

You have already heard from the Department earlier. Secretary Spellings, I think, addressed you earlier, and Tom Luce addressed you yesterday. I want to focus on the impact of the President's American Competitiveness Initiative on K–12 students.

Senator ALEXANDER. Dr. Johnson, you reminded me of something I meant to say that is in my prepared remarks. You are exactly correct that this is not just a concern of our subcommittee. The entire Committee on Health, Education, Labor, and Pensions is interested in competitiveness. It is the number one agenda for our Chairman, Mike Enzi, and we have had two very good hearings prior to these two hearings chaired by Senator Enzi, and at the first one Secretary Spellings came. At the second one, we heard from a number of educators and others from around the country. So thank you for mentioning that.

Mr. JOHNSON. And, again, thanks to you and members of the subcommittee. Improving mathematics and science education K–12 and beyond is critical to this country. For K–12 students, this improvement is part of a high-quality education. It opens the door to postsecondary education and provides a workforce with the skills necessary for success in the 21st century economy. And, again, we appreciate the efforts of this subcommittee.

There has been solid progress in mathematics education in this country in the early grades. One example: 4th grade performance of students on NAEP from 1990 to 2005 shows that the percent of students at or above basic rose from 50 percent to 80 percent. The percent of students at or above proficiency almost tripled, from 13

to 36 percent. For 8th grade students, the improvement was not as impressive, but still in the right direction.

For the same time period, the percent of students at or above basic climbed from 52 percent to 69 percent, and the percent of students at or above proficient doubled from 15 to 30. Good improvement, but not where we need to be.

Even with this improvement at the elementary level, still too many students hit the wall, so to speak, once they get to middle and high school, and I am going to make this brief, Senator.

Looking at NAEP long-term trend data, using the skills "moderately complex mathematics procedures and reasoning," performance was unchanged from 1999 to 2004. And PISA ranked student performance in this country in math 24th out of 29 member States. We are, in fact, sending better prepared students to the secondary schools, but we are not seeing the return at the secondary level. And we have got some idea where the problem starts.

In one example, 82 percent of middle school and high school students tested below proficient in Algebra I on a California standardized test. And using, again, a longitudinal study from the U.S. Department of Education, it shows that algebra is the "gateway" course for higher mathematics and postsecondary.

Because of these data, the President reached the conclusion that something needs to be done, the same conclusion this committee reached. The time to act is now.

The administration drafted a 2007 budget proposal to improve K–12 mathematics and science. In this proposal are several complementary activities, and I will briefly mention them: improving elementary school math to ensure all students are ready for algebra in middle school; providing extra support for middle school students who are below grade level in mathematics; increasing the availability of challenging college-level mathematics and science courses in high school; and support for a wide range of locally determined high school reforms.

The Secretary has initiated a National Mathematics Panel, and very soon that panel will start its deliberations, and we expect and hope that the panel will identify essential mathematic concepts. Essentially, we are looking to see if there is an analog in mathematics for what we found in the research regarding reading, the components of a comprehensive reading program.

We want the panel to help us identify effective instructional methods, and the President is proposing $10 million in the 2007 budget to begin implementing the recommendations of the panel.

I see my time will be up pretty quickly. I will be happy to go into more detail about the components of the American Competitiveness Initiative after the other speakers have a chance to speak. Thank you.

[The prepared statement of Mr. Johnson follows:]

PREPARED STATEMENT OF HENRY JOHNSON

Good morning, Mr. Chairman and members of the subcommittee. Thank you for this opportunity to testify about President Bush's efforts to improve math and science education through his American Competitiveness Initiative. Teaching and learning essential concepts of mathematics and the sciences are a critical part of a high-quality education. They help open the door to postsecondary education—especially for our poor and minority students—and help to ensure that our future work-

force has the skills needed to benefit from the increased competitiveness of the global economy of the 21st century. For all of these reasons, I appreciate the efforts of this subcommittee to bring attention to the need to improve instruction in math and science in our elementary and secondary schools.

I know you have already heard from Secretary Spellings and Assistant Secretary Tom Luce, so I will do my best to take a little different perspective and focus on our K–12 students, where they are now in terms of math and science achievement, where we need to go, and how we can get there.

SOLID PROGRESS IN THE EARLY GRADES

I want to begin by pointing out that in some ways, this new emphasis on math and science education is surprising. After all, we have solid evidence that the math achievement of younger American students has been improving steadily for the past 15 years. For example, the percentage of 4th graders performing at or above the Basic level on the National Assessment of Educational Progress (NAEP) rose from 50 percent to 80 percent from 1990 to 2005. Over the same period, the percentage of 4th graders performing at or above the Proficient level almost tripled, from 13 percent to 36 percent.

The story is similar, though not quite as impressive, for 8th grade scores on the NAEP. The percentage of 8th graders scoring at or above the Basic level climbed from 52 percent in 1990 to 69 percent in 2005, while the percentage of 8th graders at or above the Proficient level doubled from 15 percent to 30 percent.

These numbers sound pretty good, and we have not been shy about highlighting this progress as evidence that the standards-based accountability required by the No Child Left Behind Act is working to improve our Nation's educational performance.

BUT TOO MANY STUDENTS HIT THE WALL IN MIDDLE AND HIGH SCHOOL

Unfortunately, we also have strong evidence that we are not getting the job done in the higher grades, in late middle school and particularly at the high school level. I know that many of you are familiar with this data, so I will mention just two examples. First, the Long-Term Trend NAEP results show that the performance of 17-year-olds on "moderately complex mathematical procedures and reasoning" did not change from 1999 to 2004. Second, this underperformance has widened the gap in mathematics achievement between U.S. students and those of other countries. According to the 2003 Program for International Student Assessment, American students ranked 24th out of 29 members of the Organization for Economic Cooperation and Development in mathematics literacy and problem solving.

Data suggests that low achievement in high school math starts when students do not obtain the skills necessary to take and pass algebra. In 2004, for example, 82 percent of middle- and high-school students in California tested below the proficient level in Algebra I on the California Standarized Test. These results are particularly alarming in light of longitudinal studies conducted by the Department showing that Algebra is a critical "gateway" course on the path to postsecondary education.

THE AMERICAN COMPETITIVENESS INITIATIVE

President Bush looked at this data and reached the same conclusion as this subcommittee: the time for action is now. This is why his 2007 budget proposed an American Competitiveness Initiative (ACI) that includes several proposals designed to significantly improve mathematics and science education in grades K–12.

The ACI would fund several complementary activities intended to (1) strengthen math instruction beginning in the earliest grades to ensure that all students are ready for Algebra in middle school, (2) provide extra support to middle school students who are below grade level in math achievement, and (3) increase the availability of challenging, college-level math and science courses to high school students through Advanced Placement and International Baccalaureate programs. In addition, the ACI would support a wide range of locally determined high school reforms aimed at ensuring that every student not only graduates from high school, but graduates with the skills necessary to succeed in either college or the workforce.

To kick off this effort, Secretary Spellings will move quickly this year to create a National Mathematics Panel, which will work to identify essential mathematics content and effective instructional methods. This Panel, modeled after the success of the National Reading Panel in identifying the research-based reading instruction that informed President Bush's Reading First Initiative, will lay the groundwork for establishing a solid research base of math instruction to guide reforms at the Federal, State, and local levels. The Department is proposing to spend $10 million in

fiscal year 2007 to begin implementing the Panel's recommendations for improving math instruction in our K–12 classrooms.

The Panel's recommendations also would guide implementation of the President's Math Now for Elementary School Students Initiative, which would provide $125 million in competitive grants to partnerships promoting instructional principles and promising practices aimed at ensuring that all students in grades K–6 master the algebraic concepts that they will need to take and pass Algebra in middle school.

Grantees would target their efforts to elementary or middle schools with significant numbers of students who are at risk of not meeting adequate yearly progress requirements in mathematics under the title program. Funds could be used for professional development in mathematics instruction, the adoption of research-based instruction and promising practices, and enhanced assessments designed to pinpoint where students need help. In particular, these activities would provide significant resources to ensure that teachers with sufficient content knowledge teach students who need the most help.

We also are asking for $125 million for a companion proposal, Math Now for Middle School Students, designed to throw a lifeline to middle school students who are below grade level in mathematics. This program would award competitive grants to partnerships serving one or more middle schools for activities such as diagnosing the deficiencies of students who tested below the proficient level on State math assessments, implementing research-based interventions involving intensive and systematic instruction, continuous progress monitoring, and professional development.

In addition to Math Now, the ACI includes new incentives to encourage qualified math and science teachers to work in high-poverty schools. The proposed Adjunct Teacher Corps would use $25 million to promote arrangements under which experienced professionals with subject-matter expertise, particularly in math and science, would teach in secondary schools. Such arrangements could include part-time instruction, teaching while on leave from their regular jobs, or providing instruction online.

EXPANDING ADVANCED PLACEMENT

Another highlight of the American Competitiveness Initiative that I want to briefly mention is a $90 million expansion of the Department's Advanced Placement program. This proposal, which is consistent with a key provision in the PACE-Education Act, would train up to 70,000 teachers over the next 5 years to teach math, science, and critical foreign languages in AP and International Baccalaureate programs.

We believe that the Advanced Placement program offers a proven, scalable approach to raising expectations and increasing rigor in America's high schools, particularly those with high concentrations of low-income students that typically do not offer such curricula.

HIGH SCHOOL REFORM

Another piece of the 2007 Education Agenda, consistent with the goals of ACI, is the President's High School Reform proposal, which would provide $1.5 billion to support a wide range of locally determined interventions aimed at ensuring that a high school diploma becomes a ticket to success for all graduates, whether they enter the workforce or go on to higher education. This proposal also would require States to assess students in reading or language arts and math, at two additional grades in high school. NCLB currently requires assessments in these subjects for just one high school grade. These additional assessments would help increase accountability at the high school level and, in particular, would help teachers and principals target interventions to those students at greatest risk of not meeting challenging State academic standards and not completing high school. This is critical for reducing the roughly 1 million high school students who drop out each year, at great cost to our economy and society.

ACI BUILDS ON EXISTING PROGRAMS

The President's American Competitiveness Initiative proposes innovative, cost-effective ways to improve math and science instruction in America's public schools that would build on earlier efforts in this area by Congress and the administration. For example, for fiscal year 2006, Congress provided first-time funding of $99 million for the Teacher Incentive Fund, a program proposed by President Bush to provide financial incentives to help improve achievement in our highest-poverty schools, including achievement in math and science. And Congress recently made permanent the loan forgiveness provisions of the Higher Education Act, which help bring more individuals with math and science backgrounds into the teaching profession by of-

fering up to $17,500 in loan forgiveness for highly qualified math and science teachers serving low-income communities.

The Department also administers the Mathematics and Science Partnerships program, which provides State formula grants to help States and localities improve student academic achievement in mathematics and science. The program promotes strong teaching skills for elementary and secondary school teachers, including integrating teaching methods based on scientifically based research and technology into the curriculum.

In a broader sense, as you heard yesterday from Assistant Secretary Luce, the entire No Child Left Behind enterprise, with its emphasis on assessments, accountability for results, school improvement under title I and ensuring that all teachers are highly qualified in the subjects they teach, provides a strong push to State and local efforts to improve achievement in the core curricula, including math and science.

CONCLUSION

In conclusion, I believe the President's American Competitiveness Initiative, along with the PACE-Education Act, sends an important message to the American people, and especially to parents. No Child Left Behind reforms are taking hold and student achievement is rising, but we need to raise the bar again if we are to prepare our children for the jobs of the 21st century and benefit from increased global competitiveness. The ACI will help us reach that goal, and I urge the members of this subcommittee to give the President's proposal careful consideration as you move forward in your efforts to improve math and science education in grades K–12.

Thank you, and I will be happy to answer any questions.

Senator ALEXANDER. Senator Bingaman.

Senator BINGAMAN. Mr. Bement, why don't you go right ahead. I think people will be coming and going while we do this vote over on the Senate floor, but if you would go ahead, that would be helpful.

Mr. BEMENT. I would be delighted. Thank you. I appreciate the opportunity to testify before you on a topic of great importance to me personally and——

Senator BINGAMAN. Is your microphone on?

Mr. BEMENT. I can speak louder. It is on. And the topic is the State of mathematics, science, and technology education in our elementary and secondary schools.

As you are well aware, the National Science Foundation has been selected to play a major role in the President's American Competitiveness Initiative. One of the cornerstones of our involvement is preparing the Nation's scientific, technological, engineering, and mathematics workforce for the 21st century while improving the quality of math and science education in America's schools.

In line with the administration's focus on this vital national priority and in partnership with the Department of Education, NSF will invest $104 million in a new effort named Discovery Research K–12 that aims to strengthen K–12 science, technology, engineering, and mathematics education. We will refocus our efforts on a vital cluster of research in three well-defined grand challenges: first, developing effective science and mathematics assessments for K–12; second, improving science teaching and learning in the elementary grades; and, third, introducing cutting-edge discoveries into K–12 classrooms.

We will also increase funding for the Graduate Teaching Fellowships in K–12 education—better known as GK–12—by nearly 10 percent to $56 million, supporting an estimated 1,000 graduate fellows. By pairing graduate students and K–12 teachers in the classroom, this program has been particularly successful in encouraging

effective partnerships between institutions of higher education and local school districts. This is a win-win program.

In our budget request, NSF proposes a reorganization of the Education and Human Resources Directorate so that we can more effectively focus NSF's contributions to improving STEM education—in other words, getting more bang for the buck—to include greater emphasis on effective evaluation of the programs we fund. The American Competitiveness Initiative provides a framework for research agencies that support STEM education programs to work more collaboratively, with a greater attention to evaluating the efficacy of these programs. And I am proud to be a member of Secretary Spellings Competitiveness Council.

Last week, the National Science Board released its biennial report, "Science and Engineering Indicators." It provides a summary of the scope and quality of various facets of that enterprise and provides a wealth of information for policymakers.

One of the striking trends in the overview chapter is documentation of the pace of the increasing internationalization of science and technology. Graph after graph show the worldwide growth of investments in research and development, the increase in international scientific publications, and the expanding production of science and engineering degrees in Europe and Asia.

On the plus side, the U.S. share of the world's high-technology manufacturing grew from 25 percent in 1990 to nearly 40 percent in 2003. But a larger question is whether we are training new entrants into the high-tech workforce with the skills that are needed for these jobs.

"Science and Engineering Indicators" devotes an entire chapter to elementary and secondary education in mathematics and science. While there is some good news on this front, clearly there is also room for improvement.

For example, between 17 percent and 28 percent of public high school math and science teachers lack full certification in their teaching field. College graduates who become teachers tend to take fewer rigorous academic courses in high school, scored lower on college entrance exams, and graduated from less selective colleges.

A number of programs at NSF are aimed at improving various aspects of K–12 education. Within our Division of Elementary, Secondary and Informal Education, we have programs that range from new curricula, new pedagogical techniques, better ways to train K–12 teachers, educational activities that take place out of the classroom, and the application of new technologies to education.

In my written testimony, I have commented on several proposals in the PACE bill that would establish programs at NSF. A number of other programs that would be established in the PACE legislation, although not as NSF, are reflective of the types of activities NSF has supported over the years.

In light of the American competitiveness strategy to evaluate ongoing Federal formal and informal education programs, I feel that implementing any additional program that overlap those at NSF should await a review of our existing programs. This will allow us to determine where the greatest promise is for making a national impact on education.

In conclusion, I look forward to working with the committee to help identify and better develop the pipeline for future leaders in math and science, and I would be happy to answer your questions. Thank you.

[The prepared statement of Mr. Bement follows:]

PREPARED STATEMENT OF ARDEN L. BEMENT, JR.

Chairman Alexander, Ranking Member Dodd, and members of the committee, I appreciate the opportunity to testify before you on a topic of great importance to me personally and to the Nation's future—the state of mathematics, science, and technology education in our elementary and secondary schools.

As you are well aware, the National Science Foundation has been selected to play a major role in the President's American Competitiveness Initiative. One of the cornerstones of our involvement is preparing the Nation's scientific, technological, engineering, and mathematics workforce for the 21st Century while improving the quality of math and science education in America's schools.

NSF's investments in research and education—in discovery, learning, and innovation—have a longstanding and proven track record of boosting the Nation's economic vitality and competitive strength. Today's youngsters face a world of increasing global competition. We depend on the excellence of U.S. schools and universities to provide them with the wherewithal to meet this challenge and to make their own contributions to America's future. We need to build strong research foundations and foster innovation in K–12 science and mathematics education.

In line with the Administration's focus on this vital national priority, and in partnership with the Department of Education, NSF will invest $104 million in a new effort named Discovery Research K–12 that aims to strengthen K–12 science, technology, engineering and mathematics education. We will refocus our efforts on a vital cluster of research in three well-defined grand challenges:

- Developing effective science and mathematics assessments for K–12;
- Improving science teaching and learning in the elementary grades;
- Introducing cutting-edge discoveries into K–12 classrooms.

We will also increase funding for the Graduate Teaching Fellowships in K–12 Education—better known as GK–12—by nearly 10 percent to $56 million, supporting an estimated 1,000 graduate fellows. By pairing graduate students and K–12 teachers in the classroom, this program has been particularly successful in encouraging effective partnerships between institutions of higher education and local school districts.

In our budget request NSF proposes a reorganization of the Education and Human Resources Directorate so that we can more effectively focus NSF's contributions to improving science, technology, engineering and mathematics (STEM) education to include greater emphasis on effective evaluation of the programs we fund. The American Competitiveness Initiative provides a framework for research agencies that support STEM education programs to work more collaboratively and with a greater attention to evaluating the efficacy of these programs.

Last week the National Science Board released its biennial report, Science and Engineering Indicators. This document is a compilation of up-to-date quantitative data on the U.S. scientific and engineering research and education enterprise. It provides a summary of the scope and quality of various facets of that enterprise and provides a wealth of information for policymakers.

One of the striking trends in the overview chapter is documentation of the pace of the increasing internationalization of science and technology. Graph after graph show the worldwide growth of investments in research and development, the increase in international scientific publications, and the expanding production of science and engineering degrees in Europe and Asia,

On the plus side, the U.S. share of the world's high technology manufacturing (aerospace, pharmaceuticals, office and computing equipment, communications equipment, and scientific instruments) grew from 25 percent in 1990 to nearly 40 percent in 2003. But a larger question is whether we are training new entrants into the high tech workforce with the skills they will need for these jobs.

The Science and Engineering Indicators devotes an entire chapter to elementary and secondary education in mathematics and science. While there is clearly some good news on this front, we have room for improvement.

For example, between 17 percent and 28 percent of public high school math and science teachers lack full certification in their teaching field. College graduates who

become teachers tend to take fewer rigorous academic courses in high school, scored lower on college entrance exams, and graduated from less selective colleges.

A number of programs at NSF are aimed at improving various aspects of K–12 education. Within our Division of Elementary, Secondary and Informal Education we have programs that support a range of activities, including the development of new curricula, new pedagogical techniques, better ways to train K–12 teachers, educational activities that take place out of the classroom, and the application of new technologies to education.

In addition, we have numerous programs within our Research and Related Activities Directorates targeted at improving K–12 education. Examples of these include:

- The aforementioned GK–12 fellowship program which provides support for graduate students to provide science and engineering expertise in elementary and secondary schools;
- Research Experiences for Teachers, which provide hands-on research opportunities for K–12 teachers working with NSF Grantees;
- Science of Learning Centers;
- Geoscience Teacher Training designed to improve the quality of geoscience instruction at middle and high school levels;
- Centers for Ocean Science Education Excellence (COSEE) to promote ocean education as an exciting vehicle to interest students in science and enhance science education.

Even the most innovative programs, however, will not result in improving STEM achievement unless we find ways to scale them up and remove impediments to their broad adoption. That is where NSF's coordination with the Department of Education is important. I have met personally with Secretary Margaret Spellings and I believe we have a shared sense of mission to identify and implement high quality programs that will result in improvements in student performance. When three quarters of American colleges find it necessary to offer courses in remedial mathematics and 22 percent of entering freshman take these courses, it is clear that our high schools are not doing the job they should be doing.

Let me turn for a moment to address several of the provisions in S. 2198 that are directed at NSF, including section 132, NSF scholarships for mathematics and science teachers. This section would authorize NSF to award merit-based scholarships of up to $20,000 per year to students majoring in mathematics, science or engineering who also pursue teacher certification.

This program very closely parallels the existing Robert Noyce Scholarship program at NSF, except that the Noyce program makes awards to institutions rather than individuals. The grantee institutions are then responsible for administering the scholarship program. The benefit of this approach is that it places the management of the scholarship program—selecting recipients, setting course requirements, monitoring progress, counseling students, assisting with placement, ensuring compliance with post graduation requirements, and so forth—in the hands of the college or university.

When we established the Noyce Scholarship program we felt that it would be inefficient, if not impossible, to duplicate that management structure at NSF. Estimates were that it would cost up to one-third of the scholarship funding for administration purposes, should we choose to run the program at NSF. By comparison, the Noyce Scholarship program is administered by the recipient institutions for a 10 percent overhead. For these reasons we feel that the current Noyce scholarship program is preferable to the program proposed in the PACE-Education bill.

A second provision in the PACE-Education bill specific to NSF is section 141, which would establish NSF fellowships for mathematics and science teachers. This program would provide up to $10,000 annually for 4 years to support for certified math, engineering or science teachers who teach in their specialty areas in high-need school districts. Teachers with a Master's degree in science or mathematics education could receive 5 years' support for undertaking additional leadership responsibilities such as mentoring.

Incentives to attract and retain high-quality science, mathematics and engineering teachers in the K–12 education system should be encouraged.

Fellowships for mathematics and science could help achieve these goals, but we should examine this proposal in terms of potential cost-effectiveness. As a hypothetical example, if we applied $100 million a year (a very large program by NSF standards), we would support 10,000 teachers annually. In 5 years, we would have placed the equivalent of approximately four Fellowship teachers in each of the Nation's school districts. Ironically, the average length of a career for math and science teachers is about 5 years. The challenge is clearly not just one of recruitment of trained math and science teachers, but also their retention.

It is not the case that because we cannot do everything, we should do nothing. Because resources are limited, however, we must be very judicious in identifying and supporting programs that will have the greatest impact, all the while recognizing that many of the decisions on taking steps to improve math and science education will be made by local school districts.

A number of other programs that would be established in the PACE legislation, although not at NSF, are reflective of the types of activities NSF has supported over the years. We have, for example, ongoing programs such as the Centers for Learning and Teaching; the Mathematics and Science Partnerships Teacher Institutes; Early Career Awards; and incentives for high-risk/high-payoff research projects. In light of the ACI provision to evaluate ongoing programs, I feel that implementing any programs that replicate those at NSF should await a review of existing programs in order to determine where the greatest promise for making a national impact lies.

Finally, Mr. Chairman, let me extend my thanks to you for your leadership examining opportunities to improve innovation and competitiveness in America. I look forward to working with you and the committee to help identify, and better develop, the pipeline of future leaders in math and science. S. 2198 is being reviewed by the administration, and we would appreciate the opportunity to provide views on the bill's provisions prior to further consideration by the committee. I would be happy to answer any questions that you may have.

Senator BURR. Senator Bingaman, it is my understanding that at this time we are going to deviate from the plan to accommodate the schedule of a witness on the second panel. Governor Hunt, if I could call you up, we will call up James B. Hunt, representing the Institute for Educational Leadership and Policy from Chapel Hill, NC, the former Governor of North Carolina.

Governor, it is delightful to have you here to have your expertise in education, your perspective on a unique facility that we have in North Carolina tied to the university system, but that specializes in high school excellence in science and math. You are recognized for your testimony.

Governor HUNT. Well, thank you very much, Senator Burr.

Senator BURR. Governor, push that button and make sure that mike is on, please.

Governor HUNT. Is it on now? The light was on. Maybe I better get to another one.

Is this one on? All right. Senator Burr, thank you very much for—that is all right; I can just be on top of it here—your kind comments, and I want to say how delighted I am as a North Carolinian to have you on this committee. North Carolina has needed a member of this committee, and you will serve very well, and I want to be of any assistance that I can, and my institute does.

Let me say there has been a lot of discussion already about competitiveness issues here, and Jeff Bingaman and I, Senator Bingaman and I have served on some of those committees and groups over the years. But the greatest threat—I come from a State that has lost a lot of low-paying jobs. Senator, you know it as well or better than I do, and we could give the numbers of textile jobs, furniture jobs, many of them in your former congressional district.

Now, we regret that we have lost those jobs, but the greatest threat to America is not that we have lost a lot of low-paying jobs. It is the fact that we are about to lose a lot of high-paying, high-skill jobs.

I am on the board of a company. I was at a board of directors yesterday, a software company that has mostly hired software people in the United States and North America, but is now beginning to do so in India and China. I asked them at a board meeting, I

said, "How good are those software engineers?" They said, "They are every bit as good as the ones we produce in the United States, and we pay them one-fifth what we have to pay in the United States."

So we really are in a situation where this competitiveness thing is very serious. And the way I like to talk about it is to talk about the economic strength and the security of America. That is literally what is at stake here folks in terms of our economy.

It means that to have that, to preserve that strength, we have got to have the best educated, most highly skilled workers in the world in America, and we have to keep getting better all the time because all the rest of them are getting better and are a real competitive threat to us. And this is especially true, of course, in math and science and technology.

Twenty-five years ago, in North Carolina—we were concerned about these issues even then—we started the North Carolina School of Science and Mathematics. This is a residential school, 650 students on the campus in Durham, 350 get their teaching by distance learning. It has been highly successful. Seventeen States have copied it.

Senator Jeffords, I am delighted to see you, sir. What a great leader you have been on education.

In the last 3 years, this school produced 33 Siemens Westinghouse Prize winners. This is the most highly respected competition in America. It is judged by Nobel Prize winners. Thirty-three winners from the School of Science and Math in North Carolina in the last 3 years.

Seventy-five percent of the graduates work in science and mathematics, and many of them are starting up new companies that are competing nationwide.

One of the things it does, in addition to excellent education for these students, is to train teachers. They bring them in during the summer from all over the State. They help develop curricula that is better in mathematics and in science.

So we have done some good things there. I could talk about other things. But I want to say to members of this committee today. We have so far to go—a huge way to go. And the competition is about to clean our clock. We cannot be too serious about this, in my opinion.

I heard Secretary Johnson talking about the improvements we have made, and we have. North Carolina in the 1990s made more gains on NAEP scores in math and reading than any State in America because we worked with the business community and worked with the legislature and made a lot of progress. But recent reports have shown us where we are internationally.

A recent report on 30 countries and the Organization for Economic Cooperation and Development showed that of those 30 countries—you have probably heard these figures—the United States is 15th in reading, 18th in science, 24th in math. Of the G–8 countries, the eight countries, we are 7th in 10th grade mathematics.

Now, those are the facts, folks. We are not competitive today, and we have tried, we have done a lot of things. Senator Alexander—I remember him pushing to pay teachers more for better

teaching, and he did, the first State to do it. We have done a lot of things like that in other States now.

But we have got so far to go, and let me give you an example of why this bill is so important. In the last 5 years in North Carolina, a pretty good State university system, we produced three physics teachers. We are not doing it. And we are not alone. This is typical of the country. We are not producing those teachers, and they are not teaching our students.

So I want to say to you today that we have got to take drastic steps. You all think a lot up here about national security. I want to tell you, nothing is more important to our national security than having an excellent education system and being first in the world in education and then with our economy.

I support every provision in this bill, especially those having to do with producing 10,000 new teachers and paying supplements to those folks who will teach math and science in the poor schools.

Now, finally, Mr. Chairman and members of this committee, I want to say a couple of things that may not fall easily on your ears, but I think you need to hear them and I think everybody in this Congress needs to hear it.

We have historically said education is a local issue, it is a matter for Wilson County or Forsyth County. It is a State issue, and it will remain that way to a large extent. But we are at the point today where, if we are going to maintain our economic strength and the security of America, education is going to have to be far more a national matter.

And I want to suggest to you, Mr. Chairman—in fact, here is a way to look at it. It is not Tennessee, or Davidson County, North Carolina, against China. It is not Tennessee or North Carolina or Vermont or New Mexico, or whatever, against China. It is America against China. Of course, we want to cooperate as much as we can, but we are in competition. It is America. And America has got to be concerned about how we are doing.

I want to give you two suggestions. First of all, I want to urge that we continue the No Child Left Behind Act. We need to do some fixing of it, but it has been good for this country, and it has meant that we learn more and we are concerned more about all of America's children. And I support it, but we need to make some changes.

Second, I hope that you will enact all of President Bush's recommendations in his State of the Union address. They are good and they are needed.

But then I want to suggest that you, the Congress, ask the academies, who have done such wonderful work on this bill, ask them to develop American standards in science and mathematics that we can invite the States to put in place, both standards and develop assessments of those standards, that the Congress can invite and encourage States to put in place. And I would suggest that you provide some significant economic incentives for them to put those American standards in place so that we can compete.

And I think there are ways to do this. I think, you know, Governors have worked on this a lot. We have made some progress—not nearly enough. I have been watching this thing for 30 years, Mr. Chairman, and I have worked my head off on it for 30 years.

But we are not where we have got to be, and America has got to step up. No longer can this just be something that Governors and legislators and school boards are working on. This Congress has got to take this on. This ought to be the biggest issue for Congress in the years to come.

The final thing I want to suggest is this: You have got something in this bill that I love, and that is, pay more money to math/science teachers. I tried to get a bill through the North Carolina Legislature one time to pay a supplement to math/science teachers. I got it through one House, and I couldn't get it through the other one to save my life. How many States have done it? Any? I don't know if any are doing it. And there are people who fight against it. We have got to do it.

I would urge that you not only pass this, I would raise that $10,000 supplement to $20,000. We have some places around the country that have tried to put more money to get people to go into poor schools. It takes about $20,000, or more, to get a teacher to go into a poor school and teach. So I would suggest that you raise that to $20,000, or as soon as you can, and I think the Congress is the way to break this logjam. You can do it from Washington. We cannot do it in the States, I don't think. But if the Congress would say it is essential to our future, our economic strength and our national security to provide more math/science teachers and to pay them more money and you provide the money, we can do it. Why do you need to provide the money? Because we are putting money into trying to get Dells to come to North Carolina and to do a lot of things at the State level that we just have to do because we have got to compete with the world.

But, folks, I think this is the right thing to do. I am delighted that you are pursuing this. I want to thank every one of you individually for your interest in it and your work on it. I will be delighted to help in any way that I can, and I will be delighted to work with Governors as we get them behind this. I think they will support this idea. But I am very proud of this bill, and I hope you will pass it and enlarge it.

[The prepared statement of Governor Hunt follows:]

PREPARED STATEMENT OF HON. JAMES B. HUNT, JR.

Mr. Chairman, Senator Dodd, members of the committee, it is an honor to be here today to discuss America's competitiveness in the 21st century global economy—and the role science and math play in meeting those challenges.

The United States faces a competitive challenge not only from foreign companies but from foreign workers. Across the United States, many corporate executives are saying there aren't enough Americans with the skills to fill job openings. Just last week, the vice president of human resources for the world's largest privately held software company—which is located in the Triangle—stated he needs employees with graduate degrees in math, statistics and computer science. It has become alarmingly clear we are falling short when it comes to producing the talent companies like this need—and preparing students for the pursuit of these degrees. We are paying the cost.

Alan Greenspan was right when he said, "the United States has achieved its economic [and political] standing in the world based largely on the entrepreneurial spirit and high skill level of its citizens." But, a practical question still remains. Will workers in the United States have the skills necessary to compete with workers in China, India and South Korea in the 21st Century? I'm talking about **intellectual capital**: Creativity, Innovation, and Entrepreneurship.

Americans can—and must—compete in today's **global economy** but it will take **strong leadership and a bold new emphasis** on K–16 education. It will take a

renewed commitment to bring students to a higher level of competence—not only in math and science curriculum but also in creativity, innovation and entrepreneurship. It will take a **significant investment** in human capital for each and every U.S. citizen in order to maintain our competitive and comparative advantage. Senate bill S. 2198 is a good first step in achieving a new level of creativity and innovation among our Nation's students to enable them to successfully compete.

I have had the opportunity to travel the world on numerous trade missions to China, India, and South Korea and other developing Nations. What I have witnessed on these trade missions has opened my eyes to the challenges that exist for our Nation. Countries around the globe are educating students to compete in the **knowledge-based economy**. These workers can do the same work as U.S. workers from anywhere in the world—for less than a fifth of the cost. This presents us with a real challenge. There must be a sense of urgency not only among our political leaders but among all Americans. There is no greater time to forge ahead with **bold initiatives** to educate our citizens if they are to be prepared to compete globally.

According to a 2004 report by the National Center for Education Statistics, of the 30 countries composing the Organization for Economic Cooperation and Development, the United States ranks 15th in reading, 18th in science, and 24th in mathematics. In addition, the United States ranks 7th out of the G–8 countries in 10th grade mathematics. We don't have to look far to see what could be considered a contributing factor. According to the latest poll conducted by Public Agenda, parents don't see the urgency of science and math. **There is a clear disconnect here.** Policymakers and employers clearly see this slip as a threat to the Nation's economy. But, if our parents don't understand the importance, we can't expect our students to. America **can** do better. For the sake of our Nation's economy, and the quality of life for our citizens, **we must**.

For several decades, North Carolina has proven to be a national leader not only in education reform, but also in preparing students for the changing economy. During my four terms as governor, North Carolina set the goal of being first in the Nation in terms of the quality of its education system. We demonstrated **strong political leadership** and **consistently communicated with citizens** the need to improve education in terms of its connection to the economy. And, we **partnered with the business community** to achieve a clear understanding of the skills necessary for employment in the changing economy and to gain their assistance in driving education reform.

In addition, we focused **on supporting our teachers to improve instruction and increase recruitment and retention rates**. We also **established high standards for our teachers, administrators and students and created assessments to evaluate those standards**. Collectively, these efforts resulted in North Carolina students achieving the largest gains in math and reading achievement in the Nation on NAEP testing between 1990–2002.

Despite all of our efforts to improve education, it wasn't enough. North Carolina, much like the Nation as a whole, has faced a period of dramatic economic transition. Jobs in our agriculture and manufacturing sectors **dramatically declined**. Within a 10 year period, **our State lost more than 180,000 manufacturing jobs alone**.

Nearly 50 years ago, the vision of policymakers and business and education leaders led to an investment in 21st century industries. This included biotechnology, telecommunications and computing. Today, that vision is Research Triangle Park—a public-private research planned research park that houses some 136 companies and employees nearly 38,000 people.

These visionaries understood that proper education and training of North Carolina residents would be critical to establish a workforce capable of taking advantage of these growing industries and job opportunities. Through the years, North Carolina sustained that bold commitment to support math, science and technology education.

One example of our commitment to science and mathematics education is the North Carolina School of Science and Mathematics (NCSSM). The school opened in 1980 as the first school of its kind—a public, residential high school where students study a specialized curriculum focused on science and mathematics. NCSSM teaches science, mathematics and technology using practical applications along with integrated teaching methods. The curriculum is inquiry based—**focusing on engaging students in mathematics and science through applications that relate to specific real life applications and employment opportunities**. The school has nearly 650 students and teaches another 380 students across the State using distance learning, or online virtual courses. NCSSM administrators and teachers also **work with teachers in rural areas to help them improve their instructional methodology.**

NCSSM **has forged partnerships with a number of businesses** including IBM, which has provided $2 million to help enhance instructional technology and teach 21st century skills. The results have been exceptional. NCSSM has produced 33 Siemens Westinghouse prize winners—the Nation's premier high school science competition judged by Nobel Prize winners—in the last 3 years. **More than 75 percent of NCSSM graduates are working in the science and technology field and making significant contributions.**

The school has become both a national and international model. In 1988, the school became a founding member of the 76 member National Consortium for Specialized Secondary School of Mathematics, Science and Technology. Recently, the Minister of Singapore visited the school. He was so impressed that **he hopes to replicate a similar initiative in his country**. The NCSSM has become an international model because the faculty, administration and students have created a curriculum that **integrates science, math and technology into practical applications** and **makes learning engaging and connects it to real world applications.**

In its report recommending the establishment of the North Carolina School of Science and Mathematics, the Planning Committee Commission wrote, "The most compelling reason for doing so is that **creative excellence in science and mathematics is a worthy goal in itself**. The facts are, however, that **excellence also underlies such practical needs as more and better jobs, better living conditions, development of new and abundant sources of energy and other advances**—all of which are of great significance to North Carolina and the Nation."

Let me remind you this was written **nearly 30 years ago**. What could easily be viewed as foresight then, should be common sense now. North Carolina as a State, and we as a Nation, **face even greater challenges today**. For example, UNC System President Erskine Bowles recently said, "In the past 4 years, the UNC System has turned out only three physics teachers." It is imperative to cultivate creativity and excellence—**particularly in science and mathematics**—if we are to continue to be the world's economic leader. In addition to the School of Science and Mathematics, we have vigorously pursued opportunities to improve math and science achievement in North Carolina **to promote economic prosperity.**

The North Carolina Mathematics and Science Network was established to strengthen the quality and size of the teaching base and the number of students that graduate from North Carolina high schools prepared to pursue careers requiring mathematics and science skills. The Network provides high-quality, professional development opportunities for teachers and recruits students to mathematics and science careers through pre-college programs.

Another initiative, The **North Carolina Board of Science and Technology**, encourages, promotes, and supports scientific engineering, and industrial research applications. The Board investigates new areas of emerging science and technology, conducts studies on the competitiveness of State industry, and works with the governor and the General Assembly to put into place the infrastructure to support the next generation of North Carolina science and technology firms.

In addition, the **North Carolina Science, Mathematics, and Technology Education Center**, endowed by the Burroughs-Wellcome Fund, was established to help North Carolina achieve a scientifically literate workforce and improve science and math instruction by fostering research based and comprehensive programs of instruction. The Center also supports educational initiatives and resources to ensure academic success in science, math and technology for all North Carolina students. **The James B. Hunt, Jr. Institute for Educational Leadership and Policy**, which I chair, and the center are currently involved in planning a Science Technology Engineering and Mathematics (STEM) Summit. This is our effort to bring together educators and key policymakers to help determine what next steps we need to take **to not only catch up, but get ahead of the game**.

These initiatives are a good start to advancing science, math, and technology education progress. But I'm here to tell you **we must do much more**. I believe that the recommendations set forth in Senate bill S. 2198 are bold steps to support and advance innovation, creativity and entrepreneurship in our Nation.

In order to achieve creative excellence in science and mathematics, **it is necessary to recruit, retain and support teachers**. It is a well documented fact that the single most important element in a student's academic success **is that student's teacher**. A 1999 study by the American Educational Research Association found that 27 percent of math teachers and 18 percent of science teachers **were not certified in their field**. A similar study found that 45 percent of biology students, 61 percent of chemistry students and 63 percent of physics students from 1987 to 1999 **were taught by teachers not holding a major or certification in that subject. This is an injustice to our students—and our educational system.**

I strongly support Senate bill S. 2198's recommendation to recruit and provide scholarships for 10,000 science and math teachers. I particularly support the provision to provide bonuses to participating teachers in underserved schools. **We must invest in our teachers if we hope to improve the education progress of our students.**

Recruiting and retaining teachers is only the beginning. **It is critical to provide teachers with professional development and enrichment opportunities**. I helped establish the National Board for Professional Teaching Standards for that very purpose. The goal is to advance the quality of teaching and learning by **maintaining high standards, providing certification for teachers who meet these standards**, and by **capitalizing on the expertise of National Board Certified Teachers.**

The recommendation of Senate bill S. 2198 to strengthen the training and education of 250,000 teachers is critical to provide teachers with the ongoing development they need to be successful. **It is imperative that we start treating our teachers as professionals**. They have the responsibility to help shape the minds that will run our corporations and influence education policy of their own in the future. **They are one of our Nation's most vital resources. We should treat them that way.**

In addition to supporting K–12 education progress and teacher recruitment, retention and professional development, **we must focus on enhancing our institutions of higher education**. I strongly support Senate bill S. 2198 provisions to support and enhance institutions of higher education through increased scholarships, fellowships, Federal tax credits, and visa processes.

American higher education has long been the envy of the world. For decades, students have come from across the globe in search of this education. Decades ago, they also stayed and contributed to our workforce. We can no longer depend on that. Now, developing countries around the world are creating first-rate higher education systems. As a result, more students are choosing to stay and contribute at, or closer to, home.

All of these things are important. But, **equally important is the education our students receive at our colleges and universities—especially our future teachers**. They must be prepared to take their place in our workforce to help America remain strong. **Their preparation—here in America—must be the best the world has to offer. It is our obligation to make sure that happens.**

Thank you for the opportunity to testify today on what has become, in my opinion, a national crisis of global proportions. I will be happy to answer your questions.

Senator ALEXANDER. Governor Hunt, do you have another 5 or 10 minutes for a round?

Governor HUNT. I do, yes, sir.

Senator ALEXANDER. Why don't we go to Senator Bingaman first and then Senator Burr and then Senator Jeffords.

Senator BINGAMAN. Well, thank you very much, Mr. Chairman, and, Governor, thank you for all your leadership on education issues. Ever since I came to Washington, you are the go-to person as far as actually making progress in a State. And I admire greatly what you have been able to do, what you were able to do in North Carolina, and what you have been able to do nationally. But you are right, we have got a long way to go, and my concern, frankly—and I am going to get into this with our other witnesses. My concern is that the prescription that we have come up with—I mean, I commend the President for putting this on the national agenda, as he did in his State of the Union speech. And Senator Alexander and Senator Domenici and I urged him to do that, and he was planning to do it anyway, I believe. But at any rate, he did it, which is great.

I don't see in the budget that has been submitted to the Congress the kind of follow-through that I think is required in order to actually make substantial progress. I mean, this is a big undertaking if we are going to be doing the kinds of things that we all think need to be done here.

I think that, you know, we can have a lot of discussion around here about exactly how the programs are designed and which agency is responsible for what and all of that. But sooner or later, it comes down to how much are you willing to commit by way of resources to see some things change.

Governor HUNT. Absolutely.

Senator BINGAMAN. And that is where we all fall short. And, of course, we have got a budgetary bind that we have gotten ourselves into, so we do not have enough money here in Washington. We have got big deficits. We have got inadequate revenue. And so it is very hard—I mean, you know, you feel like you are favoring a particular area of the budget if you do not cut it too much. That is sort of the mentality around here. And so we are not able to do what we need to do. I don't know if that is just sort of a lament on my part, but if you have any comments, I would be anxious to hear them.

Governor HUNT. I do, Senator. I wish we could go out, I wish this committee would go out and do a survey of the people of America and ask if they want Congress to put more money into education. You know what it will come out to be? About 70 or 80 percent will say yes. I guarantee it. They want us to do it. They understand it and they want us to do it.

Now, I know you have got problems, and I know we have put a lot into Iraq, and we have been trying to do the right thing for our country and for the world there. That is going to be phasing out. Let's take the money we have been putting in Iraq and start putting it in education, gradually. As that phases down, phase this up.

And, by the way, if you have to borrow some money to put it into education—you borrowed it for other things. Borrow it for this if you have to.

Now, I am a balanced budget man. I got the constitutional amendment through to require it in North Carolina, although we have always had it. But this is so important. This is as important as waging a war. In fact, it is the big competition among countries and is going to determine who is going to have both the wealth and the jobs and the power in the future.

Senator BINGAMAN. Thank you, Mr. Chairman.

Senator ALEXANDER. Senator Burr.

Senator BURR. Thank you, Mr. Chairman.

Again, Governor, thank you for your willingness to be here. More importantly, thank you for your passion for education. North Carolina has been the beneficiary of that, and we do have a unique facility in the North Carolina School of Science and Math, affiliated with the university system, which is an unusual model and not necessarily that part of it did others follow around the country.

Let me ask you, how important do you believe that there is that higher education component to the School of Science and Math and what effect that might have on the success of the high school component?

Governor HUNT. Oh, it is absolutely essential. We have to treat these together, Senator. Higher education must prepare the teachers—and prepare them to a high level, by the way. I often like to say to folks in higher education, Listen, you cannot leave it up to the dean of education. The chancellor, or the president of the uni-

versity, or whatever you call them, has got to take this seriously and work with the dean and make sure that education in arts and sciences are working together so that our teachers learn to high standards and they understand the subject matter and they are masters of the pedagogy and all of that. And, of course, they then have to do a lot of the professional development work with teachers. We have got studies that say it is not just a matter of how much you pay teachers, it is how well you continue to develop them professionally and work with them after they get in so that the experience is fulfilling and they do not get burned out and they want to continue.

And, by the way, the North Carolina Center for the Advancement of Teaching up in Cullowhee that you have been to is a great thing, sort of an Aspen for teachers. They go there and they get renewed and revitalized, and they want to continue teaching instead of quitting as they had intended to do.

But higher education and K–12 have to work hand in glove in this.

Senator BURR. Governor, one of the realities across the country is that less than 50 percent of the teachers who teach math in K–12 have a major or a minor in the subject.

Governor HUNT. Right.

Senator BURR. And I think all of us believe that your express goal is, in fact, the right one and that we should put a greater emphasis behind this.

How long will it take for us to get into the system, the national system, a sufficient number of teachers who have the academic major to successfully go in and teach math and science?

Governor HUNT. Why don't you do what this Congress did and America did when John Kennedy said we are going to put a man on the moon—what did he say? In 10 years? How long was it? I cannot remember. Let's take 10 years.

Why doesn't this Congress say, with the leadership of this committee and this subcommittee, in 10 years no child in America will be taught math or science by an unqualified teacher? I would like for it to be 5 years, but, you know, let's set a goal for America, and then let's get to work producing those teachers, doing the things we need to do to keep them in the classroom, which involves a lot of things, including money, seeing that they are paid well, seeing that we continue the professional development work, and you all keep looking at what it is going to take in terms of salary.

And, by the way, we can do some additional things. IBM has a wonderful program now in which their retirees who are in math and science, they will pay them after they retire—they keep their benefits, and then they will pay them extra to be teachers. This is a wonderful thing to do. There are many ways we can do things like that.

But what I am saying is I hope the Congress for America will set a goal, and a tough goal, and you all find out what it is going to take to make that goal happen, and then put the resources in, put the mandates in. This is something we can do. We have acted like we cannot do this in America. We can do this, if we set the goal, and if we work hard, and if we make it a number one priority.

Senator BURR. Governor, I agree with you it can be done. I want to thank you for your continued support for No Child Left Behind. We have our differences in Washington, but I think it would be putting our head in the sand to not also admit we have our own problems in North Carolina and every State across the country with educators who believe that No Child Left Behind is a national program that should not exist, that it is too involved in K–12 local education. There are some days I think that if they would spend as much time trying to figure out how to make it work as they spend trying to figure out why it will not work, we would have a tremendous class of graduates versus the low expectations that we have got today.

In exercising the same opportunity that Jeff Bingaman did, let me also say that I think everything that we have talked about is a component to success. The one thing that we have yet to debate in this country that I think we have to debate is where we set our expectations. Our children do not read from us the hunger to compete at the same level, especially that Asian children do. I think it is one thing to raise a generation that believes winning is not the only thing in life, but competition is something that they are going to be faced with, this generation, my children are going to be faced with. They will compete for jobs against individuals they will never meet, who likely do not live in this country, for a job that can be placed anywhere. And they will likely have three or four careers in their life, not just jobs but different careers. The challenge is for this generation. Their ability to meet it will truly be determined by what we as a Nation set the expectations for their success and the success of this country.

So I think even though we talk about qualified teachers and we talk about investment and we talk about what we can do in the classroom, if we cannot raise their expectations, what we provide for all will go unused by some. And that would be a huge mistake.

Again, I thank you.

Senator ALEXANDER. Senator Jeffords.

Senator JEFFORDS. Since the late 1950s, we have all talked about the importance of strengthening math and science education from kindergarten through to college graduates. We have enacted a number of Federal initiatives. However, 50 years later we are still talking about how this Nation needs to rethink math and science education.

I would like to have your thoughts as to the reasons you believe we have not been completely successful at all at previous efforts. Is it the lack of funding, or are these barriers in the educational delivery system?

Governor HUNT. Senator, I think the main thing is there is so much competition for people who are good in math and science in America. You know, you come out as—first of all, we are not preparing enough in our colleges and universities, and we have not found ways to bring them in from the outside, like we would bring in an adjunct professor, you know, into higher education. We have got to be more flexible in getting the good people.

But there is so much competition for them now. The Research Triangle in North Carolina would snap them up just like this, and

the one developing in Winston-Salem North Carolina. And you have got things like that in your States.

And it is tough. You know, it is a lot easier to maybe get a degree in some of these other areas, and it may be easier to teach in some of them.

Whatever the reasons—and then, of course, at the same time this has become so much more important in the world, you know, the way the world is developing with technology and the way the competition is coming along.

So I don't want us to think we haven't done some good things. We have done a lot of good things. Our children know more about math and science. Our teachers that are in there are probably better teachers. But the world is going so fast and the competition is so tough, so that we have just got to do a whole lot more than we have ever done before.

And I want to say, Senator Jeffords, of all the people in this town who have given great leadership, who have had their heart in it, body and soul to it throughout their career, you are one of the greatest, and I am one of your greater admirers, as you know.

Senator JEFFORDS. Well, I appreciate those comments very much. In fact, I am leaving the Senate and going back to the University of Vermont to do what I think needs to be done, and that is to get our educational system in operation the way it must be. So I appreciate what you have done, and thank you for your comments.

Governor HUNT. Thank you.

Senator ALEXANDER. We have been joined by the ranking Democrat on our subcommittee, Senator Dodd, who is one of the strongest supporters of the PACE Act. I have a couple of questions for Governor Hunt, and Senator Dodd does, and then we will go back to Dr. Bement and Dr. Johnson.

Governor Hunt, you know I am one of your big fans in education. We did not worry about competing with China when I was Governor and you were Governor. We worried about competing with North Carolina. And I can vividly remember bringing our Speaker of the House, Ned McWherter, later our Governor, over to North Carolina more than 20 years ago to see your new Science and Math School, which, as I remember, cost about $10 million a year—maybe it was 5—at that time. We were trying to consider what to do.

We elected not to try to do that because of the cost, and instead we created Governor's schools, which are now in their 20th year, and are summer institutes, primarily for students. We have a Governor's school for math and science at the University of Tennessee, for 4 weeks, and it has had a phenomenal effect. As the students come in, they not only learn, but when they go back to their schools, they are heroes and heroines, and they transform attitudes.

So my question is, now looking over the 20 years of the Science and Math School and the recommendation of the PACE Committee, that each State be given some funds to do this, if they wish, and in Tennessee Governor Bredesen said he might like to do it, what is your advice for Governors and for us as we look ahead?

For example, is spending that much time and attention on such a small number of students worth the dollars, or would it be better

if it were institutes that attracted more? How could it be better related to teaching? Twenty years ago, we did not have the online opportunities we have today, so what would be the three or four things that you would suggest that someone creating a residential math and science school consider as we look ahead?

Governor HUNT. Senator, I think having one that is truly excellent, that shows the world what excellence is, is a good idea. As I said, 17 States copied North Carolina. I saw the one in Oklahoma recently.

Senator ALEXANDER. What is the cost now? Do you remember?

Governor HUNT. I am not sure exactly what the cost is. You know, it goes up. But it is a regular school. It gets the regular school funding.

Senator ALEXANDER. Right.

Governor HUNT. Then it has some additional funding, and we raise a lot of private funds. But you need examples of excellence in our society.

In fact, I remember going to regular high school in Durham and going into a science class, and the science teacher went to great lengths to show me what his students were doing and saying, "We are just as good as the School of Math and Science over there." So this competition thing really works.

But I would also recommend that pretty good size school systems have their own schools of math and science. You know, we have schools that specialize in different things. Obviously, we want every student in America to learn math and science, but we have got to have some place where we take students as far as they can go, and this is another thing I would want to say to this committee. Listen, folks, the folks who are going to do the breakthrough work, who are going to do the basic research, which means discovering new knowledge that man never knew before, that then leads to new products and services and energies, those are going to come from the brightest minds. We have got to figure out a way that we can start focusing on creativity and innovation at the same time we are trying to bring all of our students up to a certain level.

This is one area—and some of our teachers are saying this to us. We need a little more flexibility in how we can teach, you know, so we can develop creativity.

So I would say we want to improve math and science education. Every student needs to learn the basic things they need to know there. Then we need to have—I think in every school district, we need to have a special school where those who are even more interested and have greater aptitude can go. And then I would think every State ought to have one—or at least many States should.

Senator ALEXANDER. May I ask you one other question? And then do you have time for questions from Senator Dodd and Senator Kennedy?

Governor HUNT. Yes, sir, absolutely I do.

Senator ALEXANDER. OK. Here is my other question. You have done a lot of work on recognizing outstanding teaching, which we both know is a big challenge. I was at a conference this past week sponsored by the Aspen Institute. There are 400 ideas about what to do to improve education. It all boils down to parents and teach-

ers in every discussion, and since we do not know what to do about a better parents law, we end up with teachers.

In every discussion we had about teachers, all of the ideas that we came up with sort of faded because, after a few years, very good teachers had no way of being paid more for being a good teacher.

Now, you have made some comment about the so-called differential pay, as we call it, but what else can we do here to create incentives or introduce the idea in this country that an outstanding teacher deserves a financial reward? Have we made any progress in the last 20 years in developing a consensus about how to do that? If I am on the school board in Wilmington or the school board in Jackson, TN, or Springfield, MA, am I going to have to fight World War III in order to recognize a teacher who has been there for 7 years by paying that teacher $15,000 or $20,000 more a year? What comment do you have?

Governor HUNT. Mr. Chairman, you started working on this a long time ago, and I remember it. In North Carolina—let's take Wilmington, NC—if you are in a school where the school makes a year's progress—Dr. Henry Johnson helped get this underway when he was in North Carolina. The school makes a year's progress, the teacher gets a $600 bonus. I believe it is $750. If you make 110 percent progress, more than a year, you get another bonus. And we are developing a system whereby if all the children—you know, under No Child Left Behind—do it, you get still a third bonus.

This is not big money, but it is important money. You are rewarding success. You are rewarding the teacher teaching so successfully that the students are learning.

Now, the Teaching Commission under Lou Gerstner, which I have been serving on along with a lot of other leaders in the country, has been working with States all over the country to develop approaches to this. I think this is not something you all should mandate from here because we really don't know how to do it quite yet. But we are developing ways to do it. We need to measure student learning, and if student learning is outstanding, pay the teachers more money.

I have found teachers are entrepreneurs. When we started this system, they said, oh, the teachers won't keep the money, they will give it to somebody. No. They need the money and they keep the money.

So I would encourage you all to encourage that as much as you can. But, in addition to that, of course, we have got to give them the kind of support they need to have, and I wouldn't want to leave this town today and go to New York City for a Carnegie Foundation Board meeting without saying that we started the National Board for Professional Teaching Standards over 20 years ago. I am looking at members of this committee who got that underway, Senator Dodd and Senator Kennedy in particular at that time, and many others. You were the Secretary of Education, Mr. Chairman, and you supported that idea. Not everybody did. We have got about 50,000 nationally board-certified teachers now. One-fourth of them are in our State of North Carolina, and they are one of the reasons that in the 1990s our NAEP gains were more than any State in

America. So I thank you for that, and I hope you will continue to support it.

Senator ALEXANDER. Thank you.

Senator Dodd.

Senator DODD. Well, thank you, Mr. Chairman, and, Governor, good to see you again. It is wonderful of you to be here. I cannot imagine a good conversation about education and not have you be a part of it, so thank you immensely for all the things you have done over the years.

One of the reasons I got so interested in this subject matter and the sense of urgency about it was a quote—and I want to read it, because it was in this summary of the "Rising Storm" report here, "Rising above the Gathering Storm." And I want you to address it, if you would, because it speaks to this issue that I think people do not understand. I think people have this sort of notion that when World War II started, we had several years, in fact, some time to get ready and to build up and then react to things. And one of the things I found startling in this report was the warning issued by the authors of this report over the abruptness with which this change can occur.

I think there is a sense that somehow we will get this right in time, and I will just read this quote. It says, "Although many people assume the United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost, and the difficulty of recovering a lead once lost, if indeed it can be regained at all."

Now, I wonder if you might just comment on that particular notion about the abruptness of the change that can occur in the world we are living in, number one.

No. 2, you made a recommendation which I find very exciting here, and that is the notion that Congress should ask the National Academy to set standards in math and science and then incentivize the States to adopt and develop those standards in math and science. I wonder if you might develop that thought a little bit.

And, thirdly, could you expand on the comment you made that was not in your prepared remarks, about the global nature of education. I have lived in a two-room schoolhouse in Connecticut for the last 25 years. It was the successor schoolhouse to where Nathan Hale taught in the little town I live in. He taught in a one-room schoolhouse and that schoolhouse got too small. They then built a two-room schoolhouse. And basically children growing up in the 1850s in that schoolhouse competed with children from across the river, and down the road—New Haven and Hartford. Obviously in the 20th century, it was children in Connecticut competing with children in New York or Massachusetts, maybe North Carolina. The 21st century obviously is a very different place, and yet we are still basically structurally addressing K–12 education as if the educational system involved the house I live in today, the schoolhouse built in 1853.

And so I wonder if you might develop further what we could to become much more engaged as a national legislative body in the K–12 education process.

Governor HUNT. Senator, with regard to the latter statement or issue, I think it is a matter of saying America has got to take on this challenge as a Nation. And it is so crucial that the people in this—listen, there was a time when if you really wanted to do something about education, all you did was run for the school board. My wife was on it. Or run for Governor or run for the legislature. And that is where we decided education. And that is still going to be a big part of it. Locals and the States are going to run the schools, primarily. But these standards that enable us to compete have now got to be national. I want to call them "American standards." Let's not say "national." Let's say "American standards."

We have got to have an American effort behind it. We do not ask, we will send Canada to fight a war in Iraq, although plenty of folks in my Presbyterian church are going, some of them for the third time. But that is an American effort. We are in that kind of a contest, folks. It is every bit as important and tough as a military competition. Maybe tougher. And that is why we have got to have an American effort.

With regard to the abruptness, I think they are exactly right. Listen to the academies. They have got this right. And let's follow their advice. It is happening already. I said before some of you came in here, I was at a board meeting of a company yesterday where their software engineers—they are beginning to use some in China and India. I asked a board meeting, "How good are they?" I thought they would say, "Well, you know, they are not too good, but we do not pay them as much." They said, "They are every bit as good as the ones we have in America, and we pay them one-fifth as much."

Now, where do you think the jobs are going to go? And it has happened suddenly, and they are getting better and better.

I have spoken to those kids on campuses in China and in other countries around the world. They are bright, they are excited, thankful to get to learn, and working their heads off. And it has happened very abruptly, and it is going to happen faster.

One American leader told me they are fixing to clean—a business leader, "They are fixing to clean our clock." And that is really true.

The other matter about the national standards, listen, I do not want to enforce those right now, although, you know, I want it to happen. But let's go about it in the right way, especially with math and science, and ask the academies to develop standards, develop the ways to measure, the assessments, and then let's encourage the States to do it. And the States, if they know that if you have got these high standards you are going to get those new companies coming in, get those new jobs—and business will work with us on this—I think you will see it happen. But you all need to push it.

Senator DODD. Thank you.

Senator ALEXANDER. Senator Kennedy.

Senator KENNEDY. Thank you so much, Governor, for being here. It is always inspirational to listen to you, as many of us have over a long period of time. So many have benefitted from your lifetime of dedication and commitment to education. It has been an extraordinary life of public service that you have had, and we are very,

very grateful to you for sharing your time today with the committee.

I want to specifically sort of talk about the concept of P–16 councils, and what you have done along those lines in North Carolina to bring together the business community, Government, colleges and school districts. This cooperation is a key element in terms of the development of education in your State, and I wanted to underline a point that you made. If the United States is going to be the number one economy, we have to be the most innovative economy. And to be an innovative economy, we have to do what you have suggested, and it is a matter of national security as well. This is all related to national security, to having the best technology that is going to be available with the best-trained workers and, best-led companies. This is a challenging time, and I think an important point was made as I was listening to the chairman and Senator Dodd. It's critical to get that sense of urgency out there among the American people. It is important, because, on the one hand, still education decisions are going to be made by the school board in Pocatello, but on the other hand their students are going to be competing with people in Shanghai and Beijing and others. So that relationship you have described is essential to ensuring our ability to compete, and I look forward to reading more carefully about how that can be done and done so it can have the broadest kind of support, both politically and nationwide.

But what is the magic that you have had in North Carolina? We have a successful business community in my State and they've been instrumental in putting in place our States education reform efforts. Massachusetts is first in the Nation for 4th grade and 8th grade on the NAEP reading test. But reforms in Massachusetts were put in place really before the No Child Left Behind Act, and then when the No Child came in, the State was really on top of it. They knew what that was about, and we have got a ways still to go. But we have seen reductions in achievement gaps that have been really impressive.

Governor, tell us about how you were able to get each of these groups together and what a difference that has made, because that is very unique. Some places have had the business community involved. As I mentioned the business community in Massachusetts was very involved in getting education reforms implemented. I think they would welcome the opportunity to build even stronger partnerships on these issues.

But what has been the mark of the success of that rather unique partnership? I had the chance to go down to North Carolina and listen to some people down there a couple of years ago. But what is the magic of bringing that together?

Governor HUNT. Well, Senator, we thank you for coming on that occasion, and thank you so much for all your leadership.

The key to it is to talk to people about things they care about the most. Traditionally in the States, it has been jobs, and it still is. But it is also America's security, our military security, being safe. It is our health care. It is all of these things.

As Governor for 16 years, four terms, I found that when I partnered with the business community, with the business leaders, with the IBMs and the GlaxoSmithKlines and all those, and all the

others—the banks and all the rest—first, I found they wanted a partner. They understood. They are the consumers of what we are turning out. They are the ones who were having to compete around the world. And I found that they are ready to step up. If they are asked, they will do it.

I want to call your attention because I have been with them recently, the U.S. Chamber of Commerce now has something new called the Business Education Network, BEN. I was talking to Tom Donohue about it a week ago. And I have been urging the U.S. Chamber to get aboard and to get involved in this. We have had CED and a lot of others have been working on it. The U.S. Chamber is getting into this now. And I would urge you all here to work with the business community and with the academies, with all levels, higher education, K–12, early childhood—all of this has to be done—to build this kind of commitment to an America that is the leading place in the world and will continue to be for innovation. That is our key. It is—you know, we have got to be thinking of new things, and if somebody steals it or whatever, we come up with something new again, more, it just continues to happen from bright minds. But we have also got to be thinking about how do we teach creativity. I want every child to get up to grade level, but I want a lot of these kids to be so bright that they will come up with those new discoveries which will mean the new technologies and new products and new businesses, and we have got to continue to do that. But it is all about education, and thank you so much for the leadership that all of you at this table and on this committee have given.

And I would urge—I would leave you with this challenge. I know Members of Congress like to be on the Finance Committee, and I know partly why. I understand about Armed Services, and all the rest of these things. Going forward, this Health, Education, Labor, and Pensions Committee needs to be the most important committee in Congress. The new commitments in America need to be in education more than anything else, including health care, by the way. And I would just urge every one of you here—I am looking at real leaders. I know who all of you are. I would hope that you would do the pushing and pulling your partners in, get the business community to pull in folks that maybe do not understand it, just coming from you or educators. Build that kind of powerful partnership for education, then for economic strength, and national security. And I thank you very much for letting me come.

Senator ALEXANDER. Thank you, Governor Hunt, and thank you for staying.

Before you leave, Senator Dodd and Senator Kennedy were not here when you said what you thought about the PACE report and the provisions in it, and I wonder if you could speak on it again in a sentence or two.

Governor HUNT. I support it 100 percent, especially the part about training 10,000 new teachers and paying supplements, more money to math and science teachers. We have not been able to crack that at the State or local level. If you all put the money in, we will get it done.

Thank you very much.

Senator ALEXANDER. Thank you, Governor Hunt.

Now, let me ask, Dr. Bement and Dr. Johnson, how is your schedule. Have you got a few more minutes for us? Let me invite you to come back and let me ask the other three witnesses to come back who have not yet testified. I understand we may have votes at about noon. What I thought I would do is ask the other three witnesses to take their seats at the table along with you, let us hear a summary of their testimony, and then let all the Senators have a chance to ask all of you questions. Would that be acceptable to you? Thank you. However, at this time I would ask that the statement of Senator Kennedy be included in the record.

[The prepared statement of Senator Kennedy follows:]

PREPARED STATEMENT OF SENATOR KENNEDY

I commend Senator Alexander for convening this second of two hearings on the critical issue of improving math and science education in this country. I commend him and Senators Bingaman and Mikulski for their bipartisan work on the PACE Act, and I look forward to working with Chairman Enzi and the rest of the committee on these critical issues.

We're grateful to Henry Johnson from the Department of Education and Arden Bement from the National Science Foundation for being here today, as well as Governor Hunt, who has so generously made the trip from North Carolina.

We know that globalization is creating immense new challenges for our country, our economy, and our everyday lives. Report after report shows that America is losing its competitive edge in education. It is unacceptable that American students rank 28th out of 40 countries—tied with Latvia—on a test of applied math skills. We've fallen from 3rd to 15th in the industrialized world in the production of scientists and engineers. Between 1985 and 2002, the number of math, science, and engineering graduates in China nearly quadrupled, while the number of U.S. graduates in these fields grew by only 3 percent. Other Nations are gaining on us because they give higher priority to education.

To reverse these trends and put America back on the right track, we must inspire a renaissance in math and science education. But we won't succeed if our focus is on math and science alone. We must also ensure a strong educational foundation for every individual. We must make sure that children are prepared for the challenges they face at every grade level, and see that their learning in elementary and secondary school is aligned with the demands of college and the 21st century economy. We must make sure as well that cost is never a barrier to getting a college degree.

The PACE Act includes many important proposals for improving math and science education, and I commend my colleagues on the committee for their leadership. The response to the legislation shows the level of broad bipartisan support for addressing this critical need. And as today's witnesses will demonstrate, these efforts are already taking root in many places at the local and State level.

I also welcome the President's commitment to improving math and science education to keep America competitive. But if we are to succeed, our solutions have to rise to the challenge. The President's proposals do not go far enough. It is not enough to tinker at the edges, or to help already talented students advance to the

next level. A $380 million investment in math and science programs is meaningless in a budget that cuts overall education by $2.1 billion.

We should do more to increase access to rigorous AP courses for low-income children, as the President has proposed. Senator Bingaman has been a leader in the Senate on this issue for many years and I've been a strong supporter of his efforts. But the reality is that many students in high poverty schools lack the basic educational foundation to succeed in those courses. One in three 8th graders attends a school that doesn't even offer algebra—a "gatekeeper" course for advanced AP science and math courses. So we must take a more comprehensive approach. We must address the entire school curriculum with that level of commitment if we're to succeed.

The international TIMSS study found that one-third of American 4th graders and one-fifth of American 8th graders cannot perform basic math functions. We can't get ahead as a Nation if our children don't have those critical skills. We must do more to help struggling students.

The President's Math Now Initiative is modeled after the Reading First program, and we have seen problems in implementing this program at the local level. We've heard from schools across America that say they were pressured into abandoning their reading curriculum, even when it was based in research. Several of us have asked GAO to investigate the implementation of Reading First, and the Department of Education Inspector General is investigating financial conflicts of interest in the program. There's a role for the Federal Government to play in helping students get ahead in reading and math—but narrowing the school curriculum in these subjects isn't the right approach.

The President's proposals also come at the expense of other programs critical to our children's success. For the second year in a row, the President has proposed eliminating funding for the Education Technology program, which helps strengthen K–12 math education and prepare students for the jobs of the 21st century. He has also proposed cutting funds for innovative teacher training programs at the National Science Foundation. Robbing Peter to pay Paul is not a strategy for success in today's education world.

Over 60 percent of new jobs today require some postsecondary education, compared to only 15 percent 50 years ago. By 2009, 6 million jobs will go unfilled because our youth will not be qualified to hold them. To keep America competitive, we need more students with degrees in math, science, and critical-need foreign languages.

But first and foremost, we must see that every talented student can afford a college degree.

Half a century ago, we responded to the challenge of Sputnik, by enacting the National Defense Education Act, which doubled the Federal investment in education, and led to our dominance in the arms race and the global economy. This week I am introducing a New National Defense Education Act to help this generation meet the modern international challenge.

The bill seeks to modernize the American education system, from pre-kindergarten through higher education, and arm students with the 21st century knowledge and skills.

The bill helps States meet national and international benchmarks and provides grants to States to create P–16 Preparedness Councils to align student learning with the demands of college, the 21st century workforce, and our Armed Forces. It invests in math, science, and critical-need foreign language teachers for schools in need. It guarantees students that if they work hard and get into college, cost will not be a barrier to a degree.

College and graduate school would be tuition-free for low- or moderate-income students who study science, math, engineering, technology, or a critical-need language. Funding would be doubled for NSF education programs, new investments would be made in math, science, engineering and technology textbooks and laboratories for high-need schools.

We can't keep America competitive unless we invest in a strong education for everyone, from birth through adulthood. I look forward to hearing from our witnesses today. I know that together we can fulfill the promise of every child and every student in America. The Nation's future depends on it.

Senator ALEXANDER. Let me introduce the three other witnesses and ask you to come forward and take your seats.

Tom Rudin is the vice president for Governmental Affairs for College Board. We were looking forward to having President Gaston Caperton, whom we all know, but he got the flu and couldn't come today. Please give him our best and we are sorry to miss him.

Also, Joshua Tagore, an outstanding student at the University High School for Science and Engineering in Hartford, CT, is here. And we are delighted he is here.

And Peter O'Donnell is here, who is a member of the National Academy's Committee that produced "The Gathering Storm," and his work in Dallas is one reason for the inclusion in "The Gathering Storm" report of the advanced placement recommendations.

So why don't we begin with Mr. Rudin, then go to Mr. O'Donnell, and then Joshua Tagore. And if you can summarize your thoughts in 5 minutes or even a little less, that will leave the Senators more time to ask you questions.

Again, Dr. Bement and Dr. Johnson, thank you for your patience.

STATEMENTS OF THOMAS W. RUDIN, VICE PRESIDENT FOR GOVERNMENT RELATIONS, THE COLLEGE BOARD, NEW YORK, NY; PETER O'DONNELL, JR., PRESIDENT, O'DONNELL FOUNDATION OF DALLAS, DALLAS, TX; AND JOSHUA TAGORE, STUDENT, UNIVERSITY HIGH SCHOOL FOR SCIENCE AND ENGINEERING, HARTFORD, CT

Mr. RUDIN. Thank you very much, Mr. Chairman. Is this on? I believe it is. My boss, President Caperton, sends his regrets and regards and wishes he could be here. He appreciates this opportunity and wants to assure you that his absence had nothing to do with the Fat Tuesday celebrations from last night.

[Laughter.]

He really does have the flu, regrettably.

We are thrilled at the College Board with this new legislation, and particularly the provisions that have to do with the Advanced Placement Program. The Advanced Placement Program, as you know, is a national program of 38 college-level courses offered in

high school. This year, about 1.3 million students will take about 2.3 million AP courses and exams in schools all across the country, and AP has really become a driver for the kind of education reform, the kind of rigor that you all are looking for in the PACE legislation. So we are thrilled to see that it is prominent in the bill, and we are thrilled to be part of the process of hopefully working with you at all levels to both get the bill passed and to implement the Advanced Placement components of that legislation.

The AP Program is really about three things, and I will just highlight those briefly and hopefully save time for questions.

First of all, it is about excellence and high standards. As you know, AP is college-level work offered at high school. It sets a high standard, but students who achieve in the AP courses leave high school ready to excel in college, in work, and especially in math and science areas. Let me just highlight one statistic that illustrates this point.

You have heard about the TIMSS studies and how we compare on a global level in these international assessments. We are next to last in advanced mathematics among all countries in the world. But among AP students in the U.S. who score a 3, 4, or 5—that is a passing grade on the AP exam—those students are first in the world in advanced mathematics, and AP students who score a 1 or 2 on the AP exam, that does not get you college credit, but it is still an achievement. They are second in the world in advanced mathematics. So AP represents high standards and high rigor.

The second thing about AP is it is a commitment to equity. We are trying to open the door to AP, and we are not just saying let's open the door and hope more kids take these courses. We know a lot more kids can take these courses and excel in them, and let me give you two examples.

This past year, 107,000 students in the country got a 3, 4, or 5 on the AP calculus exam. But through some analysis and research we have done that correlates achievement on the PSAT with success in AP calculus, we can identify and we have identified by name 500,000 additional students who could excel in these AP calculus courses. Senator Alexander, for example, in Tennessee, 1,100 kids got a 3, 4, or 5 in AP calculus last year, but we know the names of another 8,000 kids in Tennessee who could take and pass the AP calculus exam if they were just given a chance. But oftentimes the course is not offered. Oftentimes students are not encouraged to take these rigorous courses. So if you are looking for a "quick win," get these courses offered in all American high schools and open access to them. You will have hundreds of thousands of students throughout the country taking and succeeding in rigorous math, science, and world languages courses.

And, finally, AP is a program that already has an existing infrastructure in place. If you fund the AP Program as outlined in the PACE bill, you do not have to create new teacher training programs. Your colleges and universities already institutes, 1, 2, 3-week summer institutes for AP teachers. That infrastructure is in place. If you fund this program, there are already 130,000 trained AP teachers out there. The President is calling for 70,000 more, and we need them, but we have the infrastructure in place to train them.

And, finally, the opportunity exists already to offer these AP exams that are graded by 6,000 teachers every year who come together in a central location, spend 2 weeks grading AP exams, and giving feedback to the students. The infrastructure exists. Every dollar you put into AP will go directly to the students and teachers.

And so we strongly urge support for the legislation. We would love to be part of the team that moves this out into the schools and districts and makes it work, and we are ready to help you in any way we can. And we leave you with a final thought that many people see AP as just for the elite kids or so-called select group of kids. Our experience is that AP is for the prepared student with a high-quality teacher. It is not for the elite student. It is for really anybody who is prepared to enter these fields.

Thank you very much.

[The prepared statement of Mr. Caperton follows:]

PREPARED STATEMENT OF GASTON CAPERTON

ANCHORING MATHEMATICS AND SCIENCE EDUCATION REFORM IN AN EXPANDED ADVANCED PLACEMENT PROGRAM

INTRODUCTION

The College Board is a national not-for-profit association of more than 5,000 member schools, colleges and universities, with a challenging mission: To connect students to college success. One of the College Board's most ambitious and important teaching and learning programs is the Advanced Placement Program (AP). As a set of 38 college-level courses taught in high school, AP has become the most influential general education program in the country, and it represents the highest standard of academic excellence in our Nation's schools. The Advanced Placement Program is a collaborative effort between motivated students, dedicated teachers, expert college professors, and committed high schools, colleges, and universities. Ninety percent of the colleges and universities in the United States, as well as colleges and universities in 30 other countries, have an AP policy granting incoming students credit, placement or both on the basis of their AP Exam grades. Many of these institutions grant up to a full year of college credit (sophomore standing) to students who earn a sufficient number of qualifying AP grades. Since its inception in 1955, the AP Program has allowed millions of students to take college-level courses and exams, and to earn college credit or placement while still in high school.

This committee is considering legislation that includes a significant role for AP in improving the quality of science and mathematics education in our Nation's schools—with the ultimate goal of increasing dramatically the number of high school graduates who enter college with the desire and ability to succeed in science, technology, engineering and mathematics (STEM) fields. I commend Senators Domenici, Alexander, Bingaman and Mikulski for their leadership in introducing the PACE Act, and I applaud the more than 60 co-sponsors for their support of this important national initiative. The College Board strongly urges committee approval of this legislation. We especially believe that support for an expanded AP math and science program in this Nation will contribute to raising standards and achievement in all of our high schools. The AP Program benefits both the students who take AP courses and those who do not take AP by promoting more rigorous standards and higher quality teaching in all classes. As such, a significant investment in the expansion of AP math and science programs will have a profound effect on the overall quality of math and science education in our Nation's schools, colleges and universities.

AP is a 50-year-old, time-tested program with an existing infrastructure of tens of thousands of teachers and a network of hundreds of training sites across the country. Funds invested in this program will not need to be dedicated to creating a new system for teacher professional development, course development, or the administration and scoring of assessments. That system already exists as a result of our efforts over the past 50 years, and as a result of the involvement of thousands of schools, colleges and universities in the operation of the AP Program. Thus, new Federal dollars invested in AP can go directly into the teacher training and student preparation and support that you envision, and that can ensure the success of this initiative.

THE AP PROGRAM

Let me say a few words about the AP Program generally, and then focus specifically on AP mathematics and science courses. The principles and values of the AP Program can be stated quite simply:

• AP supports academic excellence. AP represents a commitment to high standards, hard work, and enriched academic experiences for students, teachers and schools.

• AP is about equity. The AP Program should be open to all students, and we believe that every student should have access to AP courses and should be given the support he or she needs to succeed in these challenging courses.

• AP can drive school-wide academic reform. Schools that use AP as an anchor for setting high standards and raising expectations for all students see significant returns not just in terms of AP participation but in terms of increasing the overall quality and intensity of their academic programs.

Across the Nation, every State and most school districts are exploring ways to raise standards and ensure that all students take challenging courses in science and mathematics that prepare them for success in college and work. AP is recognized as a powerful tool for increasing academic rigor, improving teacher quality, and creating a culture of excellence in high schools. Where AP Programs flourish, schools and districts use the AP Program to support a cohesive school culture that promotes both rigor and college-going aspirations. Students who take AP courses assume the intellectual responsibility of thinking for themselves, and they learn how to engage the world critically and analytically—both inside and outside of the classroom. This is an invaluable experience for students as they prepare for college or work upon graduation from high school. Moreover, schools in which AP is widely offered—and accessible to all students—experience the diffusion of higher standards throughout the entire school curriculum.

Superintendents and principals recognize the value of AP as leverage to increase opportunity and achievement for all students. One principal from Lincolnshire, Illinois, cited the role of AP as a driver for improving all students' readiness for college and work:

AP is helping more of our students develop the skills and confidence they need to succeed. Most of our graduates who have participated in the program report being exceptionally well prepared for the challenges of college. Feedback like this reinforces our commitment to expanding college-level opportunities for all of our students.[1]

The Federal AP Incentive Program (APIP), which currently provides $32 million in Federal funding for AP expansion, mostly to increase AP access and success among underrepresented students, is working. Since its inception in 2000, more than 100 grants to States and districts have resulted in programs that have touched the lives of students throughout the Nation and promoted a college-going culture, encouraging more of our Nation's students to set high goals for themselves. The Advanced Placement Program's official Equity Policy Statement calls for "schools to make every effort to ensure that their AP classes reflect the diversity of their student population." From 2000 to 2005, the total number of students in the Nation with AP Exam grades of 3, 4 or 5 ("passing" grades that earn college credit) has grown from 494,000 to 742,000. Among African-American students, the number of AP Exams with grades of 3, 4 or 5 has grown from 18,000 to 30,000; among Latino students, the number of AP Exams with grades of 3, 4 or 5 has grown from 63,000 to 110,500.

This growth in AP is important to students, parents, schools, and districts—and to the Federal Government—for a number of reasons:

First, the most important predictor of college success for a student is not his or her high school GPA, his or her SAT score, or his or her extracurricular activities. Rather, it is the quality and rigor of his or her high school courses. Research shows that students who take more rigorous courses, such as Algebra II, trigonometry and AP Calculus, are the most likely to enroll in and complete college. Additionally, AP is a powerful predictor of college success. By providing students with the opportunity to enroll in challenging courses during high school, it is more likely that these students will have the confidence and motivation to set and achieve high standards for themselves and will be encouraged to enroll and succeed in college.

Second, students who take AP can earn college credit, which can save parents money spent on tuition and fees. In Tennessee, for example, students who take a semester's worth of AP and earn college credit on the exams can save $3,000–$5,000

[1] Dan Galloway, Principal, Adlai E. Stevenson High School, Lincolnshire, Illinois, as cited in the 2001 AP Yearbook, College Board.

in tuition and fees in the State's public colleges and universities, and much more at private institutions. By enrolling in AP classes during high school, students are able to academically prepare themselves for college, and take advantage of financial savings for their future.

Third, schools, districts and even State departments of education value the impact of AP. Students who complete AP courses are not only prepared for the rigors of college, they are extremely well prepared for the assessments required by NCLB. It is the College Board's experience that the rigorous work required in AP helps students master subject matter and prepares them for any type of assessment challenge they might face, including State accountability tests and college entrance exams.

Most AP participants are 11th and 12th grade students, but the proportion of lower-grade examinees has been growing. In the latest school year, 44 percent of the AP examinees were 12th graders and 38 percent were 11th graders, while lower-grade and other examinees accounted for 17 percent of all examinees. This latter group, comprised mostly of 10th graders, has grown from 11 percent in 2000. With regard to numbers of exams, 12th graders are more likely to take multiple exams, accounting for 52 percent of total exams in the 2005 school year, but this dominance has been steadily decreasing as other grades have been growing at a faster pace. The strong presence of 10th graders setting, and often achieving, high standards for themselves reinforces the idea that implementation of AP enhances a rigorous school culture.

AP MATHEMATICS AND SCIENCE COURSES

I share your belief, which is reflected in the PACE Act, that increasing rigorous math and science education in the U.S. will significantly boost our high school graduates' math and science proficiency—and also increase the number of students who enter college ready to succeed in science, technology, engineering and mathematics (STEM) career paths. And we urgently need to create those opportunities for our students. Today, only 32 percent of American undergraduates are earning degrees in science and engineering, compared to 66 percent of undergraduates in Japan, 59 percent in China and 36 percent in Germany. In 2004, China graduated 600,000 engineers, India graduated 350,000, and the United States graduated 70,000.[2]

The AP Program is an important tool in this Nation's efforts to increase our economic competitiveness. AP math and science students are much more likely than other students to major in STEM disciplines than students whose first exposure to college-level math and science courses is in college. For example:

- Sixteen percent of students who take AP Chemistry go on to major in chemistry in college. By way of contrast, only 3–4 percent of students who take general chemistry instead of AP chemistry major in that field in college.
- More than 25 percent of students who take AP Calculus go on to major in mathematics in colleges, and 40 percent of students who take AP physics major in physics in college.

Further, research indicates that AP math and science courses prepare American students to achieve a level of proficiency that exceeds that of students from all other Nations. For example, in the most recent TIMSS assessments, U.S. Calculus students ranked #15 (out of 16 countries) in the international advanced mathematics assessment. But AP Calculus students who scored a 3 or better on the AP Calculus Exam ranked first in the world. Even AP Calculus students who scored a 1 or 2 on the AP Calculus Exam—below the "passing" score—were ranked second in the world. AP Physics students, as compared to other U.S. physics students and physics students internationally, were also at the top of the ranking.

Most significantly, there are many, many more U.S. students who can succeed in AP math and science courses—if they are simply given the chance. This year in the United States, we anticipate that more than 100,000 students will earn a grade of 3 or above on the AP Calculus Exam—the grade typically required for college credit. But in a national analysis of the math proficiency of students enrolled in U.S. high schools during the 2005–06 academic year, we can identify, by name and school, an additional 500,000 students who have the same academic backgrounds and likelihood of success in AP Calculus as the 100,000 students who currently are fortunate enough to have an AP Calculus course available. If we look at Biology, we see an even larger gap; we expect that about 74,000 students will earn exam grades of 3

[2] Committee on Science, Engineering and Public Policy. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. National Academies Press, 2006. This report notes that America appears to be on a "losing path" today with regard to our future competitiveness and standard of living.

or higher on the AP Biology Exam this year, whereas we know that at least 640,000 additional U.S. students have the academic skills that would enable them to succeed in AP Biology if they only had a course available to them and the encouragement to take on this challenge. There are literally hundreds of thousands of high school students in the United States who are prepared and ready to succeed in rigorous high school courses such as AP Calculus, AP Biology, AP Physics and AP Chemistry. In many cases, the only thing preventing them from learning at this higher level is the lack of an AP teacher in their school or the lack of adequate encouragement and support to take the AP course.

It is important to note that participation in AP increases the likelihood that students will graduate from college within 4 years. Strong correlations exist between taking AP math and science (and all other AP subjects) and college completion. Sixty-one percent of students who have taken two AP courses in high school graduate from college in 4 years or less. Forty-five percent of students who have taken one AP course graduate from college in 4 years or less. Only 29 percent of students who have not taken an AP course will graduate in 4 years or less.

One concern that I have heard expressed about increasing the investment in AP is the notion that this takes funding away from other education programs. It is our belief that we need much more funding for all education programs if this Nation is to maintain our position of leadership in terms of economic competitiveness in the 21st century. The education piece of the pie needs to get larger, not smaller. Fortunately, the PACE Act is actually designed to do much more than launch new AP courses in U.S. schools. In fact, it is designed to provide States with resources for increasing the rigor and quality of their math and science programs in grades 6–11, using AP as a 12th grade anchor from which their schools can implement a curriculum that sequentially prepares students for the rigor of AP and college. The high standards embodied in 12th grade AP courses are just one piece of the proposed legislation, which also provides funding for professional development and student preparation in the math and science courses taught in grades 6–11. By anchoring the 6–12 math and science programs in a 12th grade AP math or science course, each grade level will foster a set of higher expectations and higher learning than is currently required and delivered in most U.S. schools. Moreover, the PACE Act is explicit in calling for increased access to AP math and science courses among students from all socioeconomic backgrounds. We share your equity commitment, and we believe that traditionally underrepresented students have the greatest need for access to rigorous course work in math, science, foreign language and culture and many other areas. If we are to maintain our position in the world, access to rigorous college-preparatory experiences in the STEM fields must be open to all students.

The College Board believes AP has tremendous potential to drive reform in a powerful way in all of our Nation's schools. No single program can have as strong an impact on overall student and teacher quality as AP. AP is not for the elite, it is for the prepared. Your support for expanded AP math and science courses and exams will prepare many more students for the opportunity to succeed in STEM fields in college and work. We respectfully urge your strong support for the PACE legislation.

Senator ALEXANDER. Mr. O'Donnell.

Mr. O'DONNELL. Thank you, Mr. Chairman. I have been invited to testify about improving student performance in mathematics and science as called for in the National Academy "Gathering Storm" report, and I am pleased to do so. I will focus on the Advanced Placement Incentive Programs which are the subject of the National Academy report, as well as the PACE legislation, and the President's American Competitiveness Initiative.

Advanced Placement is an excellent program that works to improve academic performance. Incentives work to accelerate the growth of Advanced Placement, especially among minorities. I will show you data to demonstrate that.

The Advanced Placement Incentive Program succeeds because of three fundamental concepts: the high standards of Advanced Placement, which is built on a strong curriculum, rigorous national exams, and measurable results; emphasis on excellent teacher training; and financial incentives for teachers and students. Incentives are key to the success of our program. They provide extra pay

for extra work and are paid by private donors. The incentives are listed on page 1 of the handout at your desk. I trust you all have that.

For the past 15 years, the O'Donnell Foundation has supported AP incentives programs in math, science, and English in Texas with the goal of preparing students to enter college and earn a degree. Our program, which is voluntary and open to all, is in 198 high schools. We are now in 60 districts.

I want to begin by showing you data beginning in 1995 for 10 public high schools in Dallas, which is the 12th largest school district in the country and has a 93-percent minority enrollment. Page 2 of your handout shows that passing scores in AP math, science, and English in Dallas have increased 7.6 times in 10 years. Passing scores on only math and science exams increased almost 10 times.

Page 4 shows that minority passing scores on AP math, science, and English exams have increased 17.8 times, and page 5—I particularly want you to look at that—shows that minority scores on only math and science exams have increased 33 times in 10 years.

When measured per thousand juniors and seniors, the minority students in Dallas pass at a rate nearly 3 times that of minority students in the United States.

As you have just heard from Tom Rudin, AP enables students to successfully compete internationally in math and science. Page 7 shows that our AP calculus students scored higher than students in every other country in the TIMSS math problems, compared to the U.S. as a whole, which was second from the bottom. Our AP physics students scored above all but one country, whereas the U.S. was the very bottom.

The big payoff for AP students is a high rate of graduation for college. I invite your close attention to the chart on page 8, which shows the 6-year graduation rate from Texas public universities by ethnic group and based on whether or not they passed an AP exam in the core academic subjects. You can see the startling difference between taking and passing AP and not, and it is true for all ethnic groups.

Very significant, lifetime earnings for a person with a bachelor's degree are over $2 million. A college degree effectively ends poverty for that person. We have developed several implementation features. First is a nonprofit organization that manages the program statewide, and that is part of our national committee recommendation. This has allowed us to scale up quickly while maintaining quality. Second are the master teachers who implement the program in their districts. Third is a three-way contract between the school district, a private donor, and statewide organization. This not only shares the financial burden, it lets the school know that the local community is supportive of the AP program. We now have 52 private partners in Texas. I think that could be a model for each State and gets you not only the cost sharing but the partnership you want.

The next step was to build on the success of Advanced Placement by training pre-AP math and science teachers for grades 6 through 11 and a program we call "Laying the Foundation." This program provides the curriculum, benchmarks, and training teachers need

to begin preparing students in the 6th grade to master AP courses in grades 11 and 12. In Texas today, we are training nearly 7,000 pre-AP teachers.

If you could give me just one of those books?

We have a separate book. This is biology. And we have one for each grade, 6, 7, 8, 9, and 10 for English, math, and science, and it has what the teachers need—in many cases, there are appropriate textbooks. We have what the teachers need to begin to teach these students to a high level, and these courses are aligned with the National Academy standards, the College Board standards, and in our case, the Texas Assessment of Knowledge and Skills.

When fully deployed, pre-AP will provide an enormous boost for all students by giving them an early start and putting a focus on the important goal of graduating both from high school and from college.

In conclusion, AP works to improve student performance in math and science. Incentives work to accelerate the growth of AP, especially for minorities, and we have the data to demonstrate that. I believe the Senate can enact this legislation with confidence that the programs will be implemented and that they will work.

Thank you very much.

Senator ALEXANDER. Thank you, and thank for being a pioneer in this area.

[The prepared statement of Mr. O'Donnell follows:]

PREPARED STATEMENT OF PETER O'DONNELL, JR.

Mr. Chairman and members of the committee, thank you for this opportunity to appear before you on behalf of the National Academies' Committee on Prospering in the Global Economy of the 21st Century. As you know, our effort was sponsored by the National Academy of Sciences, National Academy of Engineering and Institute of Medicine.

During my testimony, I will focus on the challenges that we are facing in K through 12 education. The committee believes the education issue is the most critical challenge the United States is facing if our children and grandchildren are to inherit ever-greater opportunities for high-quality, high-paying jobs. Our solution and recommendations to respond to the Nation's challenge in K–12 science, mathematics, engineering, and technology education are the committee's top priority.

In examining the issue of K–12 science and mathematics education, the committee found the following:

- Fewer than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations.[1]
- In 1995 (the most recent data available), U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.[2]
- U.S. 15-year-olds ranked 24th out of 40 countries that participated in a 2003 administration of the Program for International Student Assessment (PISA) examination, which assessed students' ability to apply mathematical concepts to real-world problems.[3]
- According to a recent survey, 86 percent of U.S. voters believe that the United States must increase the number of workers with a background in science and

[1] National Center for Education Statistics. (2006), "The Nation's Report Card: Mathematics 2005." (http://nces.ed.gov/nationsreportcard/pdf/main2005/2006453.pdf).

[2] National Center for Education Statistics (1999), Highlights from TIMSS (http://nces.ed.gov/pubs99/1999081.pdf).

[3] National Center for Education Statistics (2005), "International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results from the U.S. Perspective," pp. 15 & 29 (http://nces.ed.gov/pubs2005/2005003.pdf).

mathematics or America's ability to compete in the global economy will be diminished.[4]

• American youth spend more time watching television[5] than in school.[6]

• Because the United States does not have a set of national curricula, changing K–12 education is challenging, given that there are almost 15,000 school systems in the United States and the average district has only about 6 schools.[7]

Yesterday, Roy Vagelos, another member of the National Academies Committee, discussed the committee's actions related to improving the quality of America's K–12 science and mathematics teachers. This includes recruiting 10,000 of America's brightest students to the teaching profession and strengthening the skills of 250,000 current teachers through training and education programs.

These recommendations will provide public schools in the U.S. with outstanding math and science teachers on a scale equal to the size of the problem. The recommendations are based on six concepts:

1. High standards;
2. Measurable results;
3. Integrated curriculum for math and science for grades 6–12;
4. Quality teacher training that is based on content;
5. Incentives to teachers and students based on academic results;
6. Implementation vehicle in each State to manage the programs to ensure quality control and accountability.

There is general agreement that these six concepts will strengthen education, especially in math and science.

Today, I will focus on the actions we recommend that are designed to improve opportunities for students to learn and master advanced mathematics and science. This includes the Advanced Placement Incentive Program and developing rigorous, but voluntary, national K–12 science and math curricula. In addition, I will briefly discuss two other activities the committee believed was useful to expand—statewide specialty high schools and inquiry-based learning through summer internships and research opportunities for students.

The top program that the committee proposes for students involves enlarging the pipeline of students who are prepared to enter college and graduate with a degree in science, engineering, or mathematics by increasing the number of students who pass AP and IB science and mathematics courses. The proposed program would create opportunities and incentives for middle school and high school students to pursue advanced work in science and mathematics. The committee recommends that the number of students who take at least one AP or IB mathematics or science exam should be increased from 380,000 in 2004 to 1.5 million by 2010.

The committee also recommends setting a goal of tripling the number of students who pass those tests from 230,000 in 2004 to 700,000 by 2010. Students would receive incentives to both take and pass the exam including a rebate of 50 percent of their examination fee and a $100 mini-scholarship for each passing score on an AP or IB science or mathematics examination.

The reason we are encouraging more students to participate in AP/IB courses is because research has shown that those students who take AP/IB courses are twice as likely to enter and complete college as those who do not.

There is an AP incentive program in the Dallas public schools. It is based on the highly successful Advanced Placement program of the College Board which offers college-level courses taught in high school by high school teachers. Students who score a 3, 4 or 5 on AP exams are eligible for credit at most colleges and universities in the United States. For all students, especially minority students, AP is an educational coin that cannot be devalued. A "3" on an AP exam in typical high schools

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[4] The Business Roundtable 2006. "Innovation and U.S. Competitiveness: Addressing the Talent Gap. Public Opinion Research." January 12. Available at: (http://www.businessroundtable.org/pdf/20060112Two-pager.pdf).

[5] American Academy of Pediatrics. "Television—How it Affects Children." Available at: (http://www.aap.org/pubed/ZZZGF8VOQ7C.htm?&sub—cat=1). The American Academy of Pediatrics reports that "Children in the United States watch about 4 hours of TV every day"; this works out to be 1,460 hours per year.

[6] National Center for Education Statistics 2005. The Condition of Education. Table 26–2 Average Number of Instructional Hours Per Year Spent in Public School, By Age or Grade of Student and Country: 2000 and 2001. Available at: (http://nces.ed.gov/programs/coe/2005/section4/table.asp?tableID=284). NCES reports that in 2000 U.S. 15 year-olds spent 990 hours in school, during the same year 4th graders spent 1,040 hours.

[7] National Center for Education Statistics (2006), "Public Elementary and Secondary Students, Staff, Schools, and School Districts: School Year 2003–04". (http://nces.ed.gov/pubs2006/2006307.pdf).

across America is just as good as "3" on an AP exam at The Boston Latin School. AP has a proven track record with high standards and measurable results.

New concepts were added in Dallas to strengthen the College Board's AP program:

- Financial incentives for teachers and students based on exam results.
- Master AP teachers who teach at least one AP course and help mentor the new AP teachers in their school.
- Teacher training that is high quality, content-based and specifically designed for AP success. The College Board's excellent summer institutes for teachers are essential to the success of AP teachers.
- More time on task for students, including tutoring outside school hours and prep sessions on Saturdays.
- Professional management of the program by a nonprofit statewide organization run by outstanding AP teachers.
- The program is voluntary and open to all teachers and students.

The academic focus of the AP Incentive Program is the seventh AP math and science course: calculus, statistics, computer science, biology, chemistry, physics and environmental science. AP English Language and English Literature are also included. The incentives are shown in (Exhibit 1).

In 1995, the O'Donnell Foundation began an AP incentive program in 10 high schools in the Dallas Independent School District (DISD). This district of 158,000 students has a 93 percent minority enrollment and 82 percent of the students are economically disadvantaged. Nevertheless, students are achieving outstanding AP results.

Thirty-three percent of the junior and senior students in the Dallas incentive schools take at least one AP exam in math, science or English. This is over 2 times greater than the national average. (See Exhibit 2).

In 2005, students took 3,567 exams, an increase of 9.4 times since the year before the program began in 1995. (See Exhibit 3).

While the number of candidates and exams taken are important, the real measure of AP success is the number of passing scores. Passing scores on AP exams in math, science and English have increased 7.6 times during the 10 years of the program. (Exhibit 4).

Success among minority students is even more dramatic. Since the inception of the Dallas AP incentive program, the number of African-American and Hispanic students passing AP exams in college-level math and science and English has increased nearly 18 times, from 29 in 1995 to 517 in 2005. (See Exhibit 5).

To compare one school to another or to a State or to the U.S., results can be measured per 1,000 juniors and seniors. Today Dallas minority students pass nearly three times as many AP exams in math, science and English as minority students in the United States. (See Exhibit 6).

Female students have increased their passing scores in AP math, science and English by 8.4 times in 10 years. (See Exhibit 7).

Data from the Dallas model demonstrates that AP works for all types of students. The success rate of minority and female students is especially encouraging as they will be a very important part of our future workforce.

The Dallas AP incentive model is a partnership between the local school district and the private sector, with private donations supporting teacher training, as well as teacher and student incentives. At about the same time that the Dallas incentive program began, the State of Texas authorized and funded the Texas AP Incentive Program which provides State funded incentives for teacher training ($450 a year per teacher) and exam stipends of $30 per student. The State incentive program, also, has seen impressive gains in AP participation. Passing scores on AP math, science and English are up 3 times in Texas. (See Exhibit 8).

Results for minority students in the same subjects are up 4.8 times under the State funded incentive program in Texas. (See Exhibit 9).

It is very important to note that AP enables U.S. students to successfully compete internationally in math and science. Our AP calculus student score higher than students in every other country on the TIMSS test math problems, whereas the U.S. was second from the bottom. Our AP physics students scored above all but one country, whereas the U.S. was the very bottom. (See Exhibit 10).

Also important to our country's future is the high rate at which AP students earn college degrees. In Texas public universities, the 6 year graduation rate for AP Anglo students is 72 percent, compared to 30 percent for those who did not pass an AP exam. AP Hispanic students have a 6 year graduation rate of 62 percent, compared to 15 percent for those who did not pass AP exams. And 60 percent of

African-American students graduate in 6 years, while only 17 percent of those who did not pass AP graduate in that time. (See Exhibit 11).

Consider that lifetime earnings for a person with a bachelor's degree are over $2 million. This will end poverty for that person. It is especially important for minorities.

With these encouraging results from both private and State AP incentive programs, Texas has taken the next steps to accelerate AP success.

(1) Private donors created a non-profit organization, Advanced Placement Strategies, Inc. (APS) to implement AP incentive programs on a broad scale. APS is run by master AP teachers. They manage programs in the schools and are also responsible to the private donors for managing their financial support. APS is proving to be a successful implementation vehicle for expanding AP in Texas. It operates in 69 school districts in Texas, in 198 high schools and 308 middle schools. APS is currently training nearly 7,800 AP and pre-AP teachers. APS operates by three-way partnerships among the school district, a private donor in the local community and APS.

The Gathering Storm report states that implementation of the AP-IB and pre-AP-IB recommendations in each State "would require the creation of a non-profit organization staffed by talented master teachers who would help local schools manage the program and enforce high standards."

(2) Recognizing that education should begin in the 6th grade to enlarge the pipeline of AP students, APS developed a series of teachers' guides, called "*Laying the Foundation,*" for each grade, 6 through 11, in pre-AP math and science. The guides are designed to help teach the content and analytical skills that students need to master beginning in the 6th grade in order to be successful in AP math and science in the 11th and 12th grades. Pre-AP teachers are required to complete an intensive training course. Beginning in the spring of 2006, end-of-course tests modeled on the national AP exam, will be available to measure student progress in each of the benchmarks that are essential to good understanding of AP concepts. (See Exhibit 12).

The National Academy report recommends training 80,000 teachers currently in the classrooms to be outstanding pre-AP and IB teachers of math and science. This is critical given the disturbing number of teachers who teach outside their own field of study. According to the National Center for Education Statistics in 1999–2000, 69 percent of mathematics teachers and 93 percent of physical science teachers in grades 5–8 had no major or certification in mathematics or science. When fully deployed, pre-AP will provide an enormous boost for all students giving them an early start and putting a focus on the important goal of graduating both from high school and from college.

In summary, Advanced Placement is a program that works to improve academic performance. Incentives work to accelerate the growth of AP, especially among minorities. We have the data to prove it. I believe that the Senate can support these concepts with the confidence that they will work.

Of particular interest to the National Academy Committee is the ability of programs such as the University of California College Prep Program to reach currently underserved areas or populations of students with specific learning needs through online access to teachers and tutors.

The committee is pleased that this proposed action is part of the President's American Competitiveness Initiative.

The committee also proposes that high-quality teaching be fostered with world-class curricula, standards, and assessments of student learning. Here, the committee recommends that the Department of Education convene a national panel to collect, evaluate, and develop rigorous K–12 materials that would be available free of charge as a *voluntary* national curriculum.

The model for this recommendation is Project Lead the Way (PLTW)—a national program with partners in public schools, colleges and universities, and the private sector. PLTW is now offered in 45 States and the District of Columbia. The project has developed a 4-year sequence of courses that, when combined with college preparatory mathematics and science, introduces students to the scope, rigor, and discipline of engineering technology. PLTW also has developed a middle school technology curriculum, Gateway to Technology. Students participating in PLTW courses are better prepared for college engineering programs than those exposed only to the more traditional curricula. Comprehensive teacher education is a critical component of PLTW, and the curriculum uses cutting-edge technology and software that require specialized education. Continuing education supports teachers as they implement the program and provides for continuous improvement of skills.

The committee also proposed expansion of two additional approaches to improving K–12 science and mathematics education that are already in use–statewide specialty schools and inquiry-based learning.

Statewide specialty high schools are an effective way to increase student achievement in science and mathematics by providing an intensive learning experience for high-performing students. These schools immerse students in high-quality science and mathematics education, serve as testing grounds for curricula and materials, provide in-classroom educational opportunities for K–12 teachers, and have the resources and staff for summer programs to introduce students to science and mathematics.

One model for this program is the North Carolina School of Science and Mathematics (NCSSM), which opened in 1980. NCSSM enrolls juniors and seniors from most of North Carolina's 100 counties. NCSSM's unique living and learning experience made it the model for 16 similar schools around the world. It is the first school of its kind in the Nation—a public, residential high school where students study a specialized science and mathematics curriculum. At NCSSM, teachers come for a "sabbatical year", and the school has a structure and the personnel it needs to offer summer institutes for outstanding students.

Inquiry-based learning such as summer research programs stimulate student interest and achievement in science, mathematics, and technology should be encouraged—particularly those designed to stimulate low-income and minority student participation. These programs frequently involve several institutions or public—private partnerships.

The PACE legislation package is harmonious with our committee's recommendations and proposed actions for educating a new workforce and leadership in science and engineering. We are particularly pleased that the PACE-Education bill's Advanced Placement and International Baccalaureate's program authorizes the Secretary of Education to award grants to nonprofit entities to work with local school districts to provide training to teachers to teach Advanced Placement or International baccalaureate (AP/IB) and pre-AP/IB programs and that it also had the goal of increasing the number of students who take pre-AB/IB and AP/IB courses and who pass the AP/IB exams in mathematics and science.

By taking the actions proposed in the National Academies Gathering Storm report, we believe that excellent teachers and increasing numbers of students meeting high academic standards will become the academic reality. When this happens, the United States will be better positioned to compete as a country for high-quality, high-paying jobs for all Americans.

Thank you for providing me with this opportunity to testify before the committee. I would be pleased to answer any questions you have about the report.

AP Incentives in Texas

Privately Funded

Master Teachers

- $10,000 annual salary supplement

AP Teachers

- $500 - $1000 annual salary supplement:
  - to attend teacher training
  - to provide tutoring
- $100 - $500 for each AP score of 3 or over
- $500-$1000 bonus opportunity based on reaching academic goals

Pre-AP Teachers

- $500 - $1000 annual salary supplement:
  - to attend teacher training
  - to provide tutoring

Students

- $100 - $500 for each AP exam score of 3 or over
- One-half of the AP exam fee paid

NAS proposes an annual incentive payment of $1800 for AP-IB teachers and $1000 for pre-AP teachers; AP-IB teachers would also receive a $100 bonus for each student who passes an AP-IB exam in mathematics or science and pre-AP/IB teachers would receive a $25 bonus for each student who passes the end-of-course examination; proposed budget includes one-half of exam fees for AP-IB and pre-AP/IB students and scholarships for students who pass AP-IB examinations in mathematics and science.

PACE authorizes stipends for teachers who complete AP, IB, pre-AP, and pre-AB training and bonuses to the trained teachers for each student of the teacher who passes an examination in mathematics and science. For students, PACE authorizes payment of half of the cost of the AP or IB examination fees, test preparation sessions, and scholarships for students who pass AP or IB mathematics and science examinations.

Exhibit 1

Students Taking AP Exams

at 10 Dallas ISD Schools in *Math, Science, and English*

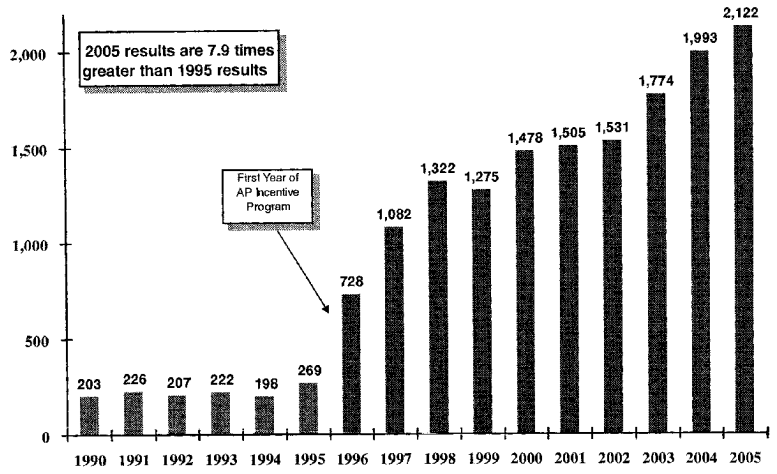


Exhibit 2

Source: The College Board

AP Exams Taken

at 10 Dallas ISD Schools in *Math, Science, and English*

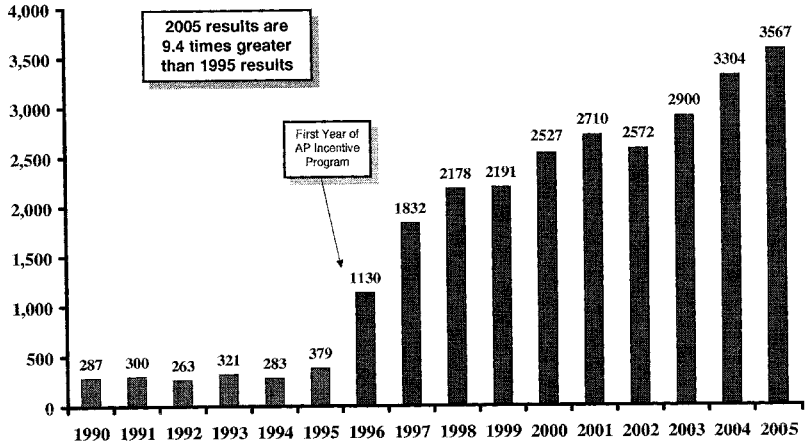


Exhibit 3

Source: The College Board

AP Passing Scores

at 10 Dallas ISD Schools in *Math, Science, and English*

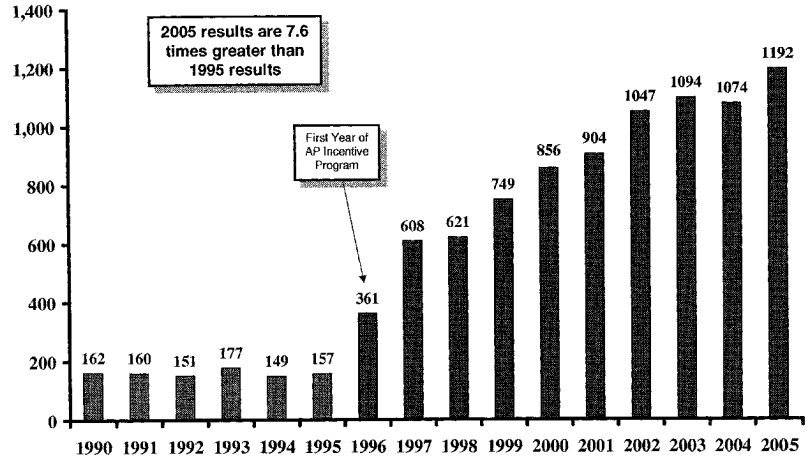


Exhibit 4

Source: The College Board, Dallas ISD

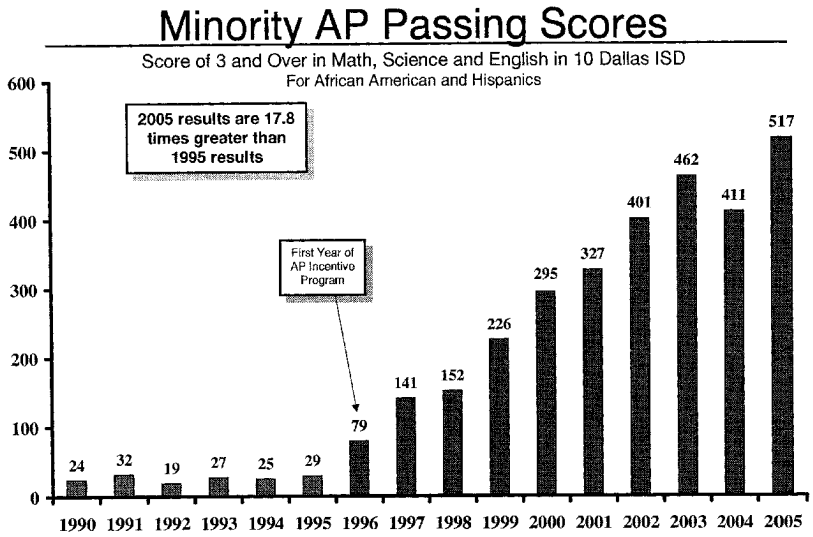


Exhibit 5

Source: The College Board, Dallas ISD

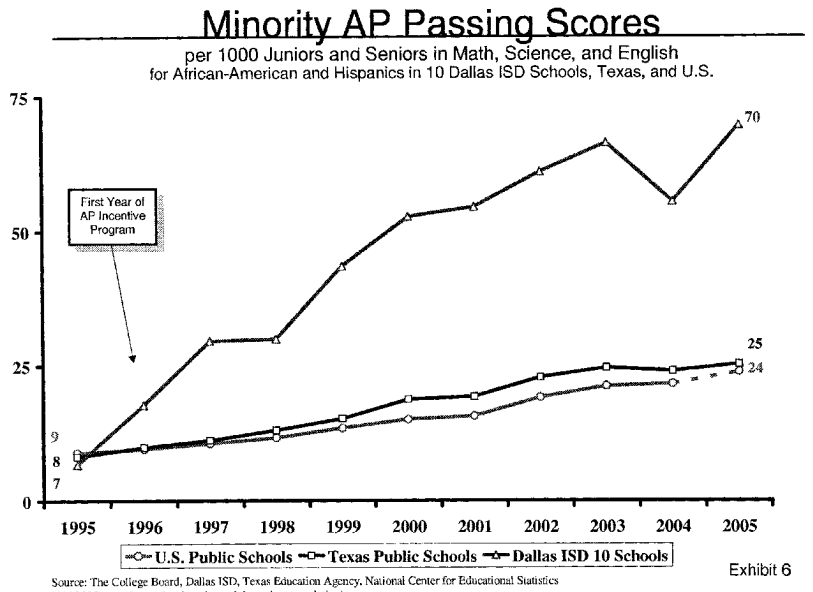


Exhibit 6

Source: The College Board, Dallas ISD, Texas Education Agency, National Center for Educational Statistics
(2005 U.S. enrollment data is estimated (through extrapolation)

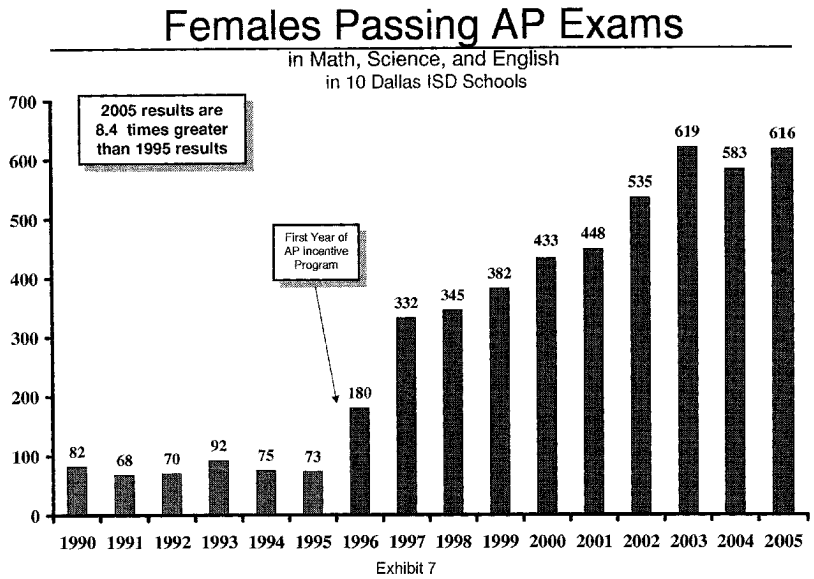


Exhibit 7

Source: The College Board, Dallas ISD

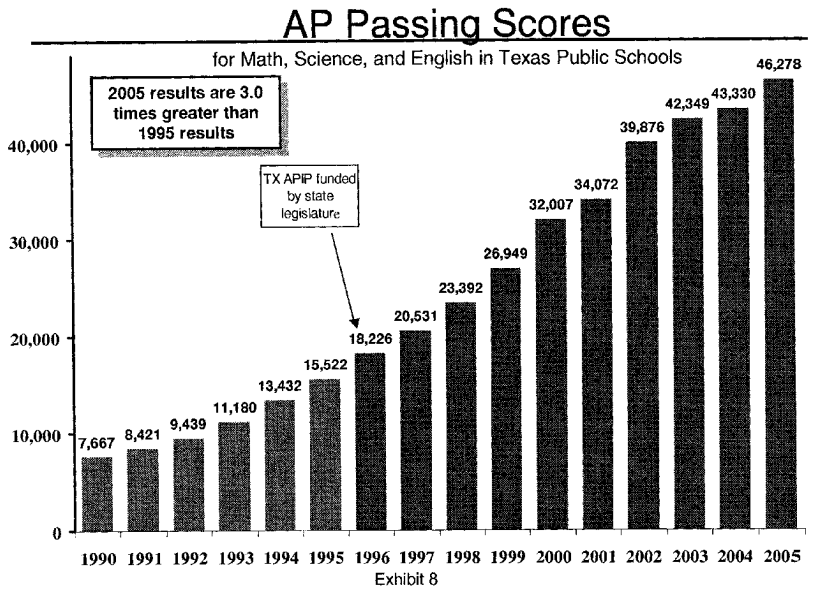


Exhibit 8

Source: The College Board

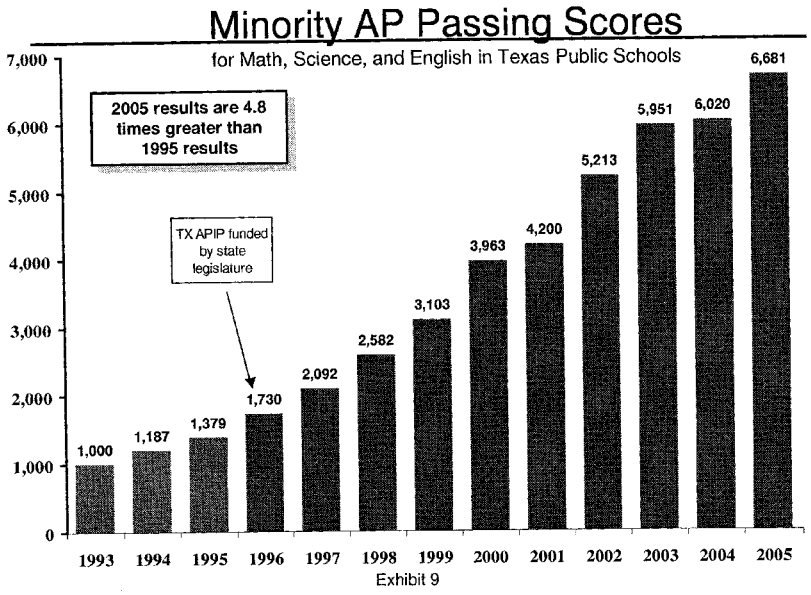


Exhibit 9

Source: The College Board

Achievement of 12th Grade Students on the International Mathematics and Science Study (TIMSS) Compared to US AP Calculus and Physics Students

Mathematics		Physics	
	Average Achievement		Average Achievement
US AP Calculus students scoring 3, 4 or 5	596	Norway	581
US AP Calculus students	573	US AP Physics students scoring 3, 4, or 5	577
France	557	Sweden	573
Russian Federation	542	Russian Federation	545
Switzerland	533	US AP Physics students	529
Australia	525	Germany	522
Cyprus	518	Australia	518
Lithuania	516	***International Average***	***501***
Greece	513	Cyprus	494
Sweden	512	Latvia	488
Canada	509	Switzerland	488
International Average	***501***	Greece	486
Italy	474	Canada	485
Czech Republic	469	France	466
Germany	465	Czech Republic	451
United States	442	Austria	435
Austria	436	United States	423

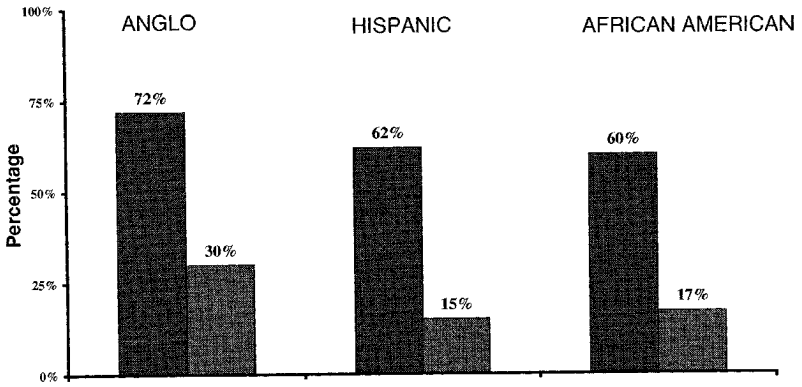
In a study conducted by the TIMSS International Study Center at Boston College. 1995 TIMSS math and science questions were administered to US AP students in 2000 with the results shown above

Exhibit 10

SIX-YEAR GRADUATION RATE*

Students who passed an AP exam compared to those who did not pass an AP exam**

Texas Public Colleges or Universities



* % receiving B.A. degree within 6 years of high school graduation based on group of students graduating in 1998, and enrolling in a Texas Public College or University (67,863 students).

** Based on AP Exams in core academic subjects of English, Math, Science, and Social Studies

Exhibit 11

Source: National Center for Educational Accountability

A Series of Teachers Guides for Pre-AP Science

Created by master AP teachers, the guides teach students the skills they need in grades 6-10 in order to pass AP science exams in grades 11 and 12. Currently there are no pre-AP science textbooks.

Each guide is designed to help the teachers teach the content, analytical skills and assessment strategies that students will need to be successful in AP science classes and other advanced coursework. Middle school content is divided into two guides, one for life and earth sciences and one for chemistry and physics. The remaining three guides in the series contain first-year courses in biology, chemistry and physics. The guides are aligned to the National Science Standards, as well as to the Texas and AP science standards.

Guides include the following:

- Course Content
- Laboratory exercises
- Foundation Lessons to teacher the skills that provide students a solid foundation for further scientific study
- Skill progression charts to move students from factual knowledge, to conceptual understanding, to reasoning and analysis
- Sample course syllabi
- Lessons demonstrating the connections between science and math
- Assessments

Schools wishing to use the guides must commit to intensive training for their pre-AP teachers. Training is conducted by Advanced Placement Strategies, Inc. and includes one week during the summer and 4 days in their school during the academic year.

The companion series of teachers guides for pre-AP math include "Connecting Middle Grades to AP Mathematics," with lessons appropriate for 6th and 7th grade students; Algebra I, Geometry, Algebra 2, and Pre-Calculus. Laying the Foundation math guides connect curriculum in grades 6-10 to calculus and statistics at increasingly challenging levels. Schools across Texas are using both the science and math guides as basic tools for their advanced classes in grades 6-10.

Exhibit 12

Senator ALEXANDER. Senator Dodd is going to introduce our next witness.

Senator DODD. Mr. Chairman, if we get this right, I want you to meet the future. He is the youngest panel member we have here today, but I had a chance to meet Josh a few weeks ago when I held a hearing on this very subject matter at the University High School in Hartford, CT. The University of Hartford has developed a program, a magnet school, concentrating on math and science and engineering. Walter Harrison is the President of that university, and in conjunction with the public school system in Hartford, has attracted students to come who have a strong interest in these areas. Josh was one of the witnesses that day.

He is actually a stellar child and has a perfect record in almost everything, except that he is a Yankees fan.

[Laughter.]

I hope today maybe I will be able to persuade him at some point in the questioning to think that the Red Sox are a better team. We are divided constituencies in Connecticut. You can divide the State right down the middle, Yankees fans and Red Sox fans.

Josh, thanks for coming today, and let me just briefly tell folks a little bit about you.

I told you where Josh goes to school, and prior to attending the University High School at the University of Hartford, Joshua attended a Hartford magnet school, where he developed a love for mathematics and science, winning honors in physical science and biology in two statewide and citywide science fairs. He participated in the Connecticut pre-engineering program, a summer program, and was honored as the valedictorian of his class. His experience at the University High School has afforded him an extensive exposure to the fields of science, math and engineering. He recently took part in an independent study summer internship program at Trinity College—this is a sophomore in high school, I remind you—a noncurriculum experience facilitated by his principal, Dr. Betty Colli, who is a remarkable woman and does a fantastic job.

He is currently considering careers in biomedical engineering, neurosurgery or cardiology. In his spare time, Josh enjoys reading and writing, swimming and biking, and his favorite baseball team, regrettably, is the Yankees.

If you want to know what can happen, in one small place, in the city of Hartford, CT, with a university working with a city, you'll want to listen to this. This could be the future if we get it right, and so, Josh, I thank you for coming today to give us a glimpse of what the 21st century could look like for America if we pay attention to people like you.

Mr. TAGORE. Thank you, Senator Dodd.

Good morning, Senator Alexander, Senator Dodd, esteemed members of the Subcommittee on Education and Early Childhood Development. I am Joshua Tagore from the University High School of Science and Engineering in Hartford, CT. It is an honor to meet you all and to represent the University High School of Science and Engineering, along with my vice principal, Dr. Lefkoff. I am proud to be part of the effort to help make our country more competitive in the fields of science and mathematics. I am here to testify on S. 2198, the Protecting America's Competitive Edge (PACE) Act.

Let me begin with a bit of personal background. I attended parochial schools and mainstream public schools through the 6th grade. At the end of the 6th grade, my parents and I made the difficult decision to leave the Avon Public Schools, one of the finest school systems in Connecticut. I enrolled at the Hartford Magnet Middle School to take advantage of the benefits of the magnet school's unique approach to education.

During my time at the Hartford Magnet Middle School, I gained a stronger love for mathematics and science, two of the school's areas of specialty. While in middle school, I participated in two statewide science fairs, and the citywide science fair. My participation in the city and the State science fairs helped to fuel my love for math and science.

Upon leaving middle school, my parents wanted me to attend a school that could accommodate my growing interest in math and science. My pursuit for knowledge in these fields was met when I enrolled at the University High School of Science and Engineering.

I am currently a sophomore at the University High School, a high school affiliated with the University of Hartford. Since being accepted to the school almost 2 years ago, I have gained an extraordinary amount of knowledge, and can say that I have participated in classes that the typical high school sophomore does not get the opportunity to experience. Some of the opportunities that were made available to me include course work in physics and engineering as a freshman, and advanced placement biology as a sophomore, which is a course designated for juniors and seniors in high school.

The class schedule was designed to be similar to that of a college student. We take all honors courses, and are offered four possible math-based courses as freshmen, algebra, geometry, algebra II, integrated math, as well as physics and engineering.

Another benefit of being enrolled in this extraordinary learning environment is being surrounded by teachers who have a tremendous amount of insight, experience and knowledge about what they teach. Students are challenged to think analytically and pursue learning vigorously.

The most recent benefit of my magnet school experience was an independent study summer internship at Trinity College. This incredible experience was birthed in a most unusual manner. Almost every week students are exposed to career professionals in the areas of science, mathematics, technology and engineering. It was through one of these weekly presentations last school year that I learned of a summer research program on the campus of Trinity College. After expressing a strong interest in the program to my principal, Dr. Betty Colli, she made arrangements for me to participate in the internship. This gave me the opportunity to work in a college-style laboratory as an intern among college students who were in their junior and senior years.

In the summer of 2005, my fellow researchers and I studied an area of the brain called the hippocampus, which is responsible for learning and memory. As a result of participating in this internship, I gained an extensive amount of knowledge on how the brain functions. I leaned how the brain sends signals, how those signals

are received, and how the signals make a person perform an activity.

In addition to gaining extensive knowledge about the brain, I became very familiar with the research environment on a college campus, thanks to the guidance of my research colleagues and our professor. From these individuals I learned that before you enter college you must establish a good work ethic, which entails acquiring effective time management skills, showing up for whatever you are doing on time, and that you must be proved to be dependable in a fashion that benefits all of your fellow colleagues.

This summer experience made a tremendous impact upon my life. Not only did I learn about the brain and the proper work ethic, but I also gained firsthand experience on what could possibly become my future career interests. As a direct consequence of my magnet school experience, I am currently considering career interests in the fields of biomedical engineering, neurosurgery or cardiology. I have learned how mathematics and all three areas of science—physics, chemistry and biology—are related, and play an important role in our everyday lives.

Current enrollment at the University High School since its establishment 2 years ago, is 200 students. Sixty four percent of them are boys, while 36 percent are girls. Two hundred students at University High School in Hartford is a start, not a final destination. I believe that if more high school students are exposed to this kind of unique learning experience as a routine part of their high school careers, as I was in my freshman year, we could help to shape a Nation of young adults, gaining interest in careers involving math and science. In this new millennium, the future of our country depends on it.

Thanks for your attention, and again, it has been an honor.

[The prepared statement of Mr. Tagore follows:]

PREPARED STATEMENT OF JOSHUA R. TAGORE

Good morning Senator Alexander, Senator Dodd, esteemed Members of the Subcommittee on Education and Early Childhood Development. I am Joshua Tagore from the University High School of Science and Engineering, in Hartford, Connecticut. First and foremost, it is an honor to meet you all, and to represent the University High School of Science and Engineering. I am proud to be part of the effort to help make our country more competitive in the fields of science and mathematics. I am here to testify on S. 2198—the Protecting America's Competitive Edge (PACE) Act.

Let me begin with a bit of personal background. I attended parochial schools and mainstream public schools through the 6th grade. At the end of the 6th grade, my parents and I made the difficult decision to leave the Avon Public Schools—one of the finest school systems in Connecticut. I enrolled at the Hartford Magnet Middle School to take advantage of the benefits of the magnet school's unique approach to education. I spent 7th and 8th grade under the guidance of principal, Delores Bolton, and a strong and dedicated staff of teachers of the very highest caliber. During my time at the Hartford Magnet Middle School, I gained a stronger love for mathematics and science—two of the school's areas of specialty. While in middle school, I participated in two statewide science fairs and the citywide science fair. My participation in the city and the State science fairs helped to fuel my love for math and science. I was also afforded the opportunity to participate in the Connecticut Pre-Engineering summer Program (CPEP). Upon leaving middle school, my parents wanted me to attend a school that could accommodate my growing interest in math and science. My pursuit for knowledge in the fields of science and mathematics was met when I enrolled at the University High School of Science and Engineering.

I am currently a sophomore at University High School, a high school affiliated with the University of Hartford. My experience at the High School for Science and Engineering has afforded me extensive exposure in the fields of science, math and engineering. Since being accepted to the school almost 2 years ago, I have gained an extraordinary amount of knowledge, and can say that I have participated in classes that the typical high school sophomore does not get the opportunity to experience. Some of the opportunities that were made available to me include: course work in Physics and Engineering as a freshman; and Advanced Placement Biology as a sophomore—which is a course designated for juniors and seniors in high school. The class schedule is designed to be similar to that of a college student. We take all honors courses, and are offered four possible math based courses as freshmen (Algebra or Geometry, Algebra 2, Integrated Math, as well as physics and engineering).

Another benefit of being enrolled as a student in this extraordinary learning environment is being surrounded by teachers who have a tremendous amount of insight, experience, and knowledge about what they teach. Students are challenged to think analytically and pursue learning vigorously. To quote one of my fellow students, "The University High School is a place where all students feel free to be smart and share with others their passion for math and science."

My journey over the last 2 years has allowed me to travel an incredible road that has offered me greater knowledge and experience. The most recent benefit of my magnet school experience was an independent study summer internship at Trinity College—a non-curriculum experience facilitated by my Principal, Dr. Betty Colli. This incredible experience was birthed in a most unusual manner. Almost every week, students are exposed to career professionals in the areas of science, mathematics, technology and engineering. It was through one of these weekly presentations last school year, that I learned of a summer research program, on the campus of Connecticut's Trinity College, which was open to high school students. After expressing a strong interest in participating in this program, my principal, Dr. Betty Colli made arrangements for me to be interviewed by the program coordinator, and then finalized the arrangements for me to participate in the internship. This gave me the opportunity to work in a college styled laboratory as an intern, among college students who were in their Junior and Senior years.

In the summer of 2005, my fellow researchers and I studied an area of the brain called the hippocampus—the area which is responsible for learning and memory. I walked into this program having very little knowledge of how the brain worked. As a result of participating in this internship, I gained an extensive amount of knowledge on how the brain functions. I learned how the brain sends signals, how those signals are received, and how the signal makes a person perform an activity. I learned that the brain is composed of cells called neurons—that neurons consist of structures such as a nucleus—the control center or brain of the cell, an axon—which sends information to other neurons, and a dendrite, which receives information from surrounding neurons. I learned that all neurons are not the same—that on the brain—there are different groups of neurons, each specializing in a different task, such as processing language or helping to coordinate movement. I learned that neurons communicate by a process called synapses, where there is space between the cells to communicate. I learned that in synapses, there are four phases, Pre-Synapses, Synapses, Post Synapses, and Post-Post Synapses. I learned that in pre-synapses, the message, sent in the form of what is called a neurotransmitter, travels down the axon. I learned that in synapses, the neurotransmitters are sent into the fluid between the two neurons, known as the synaptic space. I learned that in post synapses, the neurotransmitters are sent to a specific area on the receiving neuron, releasing the message in the form of sodium and potassium. I learned that in Post-Post Synapses, the neurotransmitters are either destroyed by cleanup cells known as glial cells, as well as enzymes, or they are recycled by the axon. This is just a small sampling of some of the knowledge that I acquired during my summer internship experience. If your head is giddy from all that detail, my head is giddy at the thought of learning more of it.

In addition to gaining extensive knowledge about the brain, I became very familiar with the research environment on a college campus, thanks to the tremendous influence of my research colleagues and our professor. From these individuals, I learned that before you enter college, you must establish a good work ethic. I learned that such a work ethic entails acquiring effective time management skills, showing up for whatever you are doing on time or even earlier, and that you must prove to be dependable in a fashion that benefits all of your fellow colleagues. The college students and the professor that I worked with always took time out to help me whenever I had a question about the brain, or our research, no matter how busy they were. In fact, they always encouraged me to come to them with questions.

This summer experience made a tremendous impact upon my life. Not only did I learn about the brain and the proper work ethic, but I also gained first hand experience on what could possibly become my future career interest. As a direct consequence of my magnet school experience, I am currently considering career interests in the fields of Bio-Medical Engineering, Neurosurgery or Cardiology. I have always had a strong interest in studies of the human body, and after taking part in this internship, my appetite for a career in a medical field has increased significantly. Having been shaped by my summer experience, I am interested in pursuing this course of study when I get to college.

I strongly believe that if there are more schools like the University High School of Science and Engineering, our country will see an increase in the number of students who will go on to pursue careers in science and mathematics. One of the things that I have learned since attending this school is how mathematics and all three areas of Science—Physics, Chemistry, and Biology—are related, and play an important role in our everyday lives. Having this experience has been one of my motivations to working towards obtaining a career in the fields of science and Engineering. My increased exposure to mathematics and science has motivated me to help make my community and my country a better place to live in for future generations. It is important to instill this within the minds of every student across the Nation. It is important that every boy and girl across the Nation know of the benefits of math and science. The University High School has been aiding that cause since it was established 2 years ago. Currently, of the 200 students, 64 percent of them are boys, while 36 percent are girls.

Two hundred students at University High School in Hartford is a start, not a final destination. I believe that if more high school students are exposed to this kind of unique learning experience as a routine part of their high school careers—as I was in my freshman year—we could help to shape a Nation of young adults who will gain an interest in careers involving math and science. In this new millennium, the future of our Country depends on it. Thanks for your attention—and again, it has been my honor.

Senator ALEXANDER. Thank you, Joshua, and thank you, Chris, for inviting Joshua, and I wish you the very best. None of us doubts your success. The only competition I can think of will be everybody competing to attract you to their college.

Senator DODD. I am just glad he does not have an interest in political science, that is all I can say.

[Laughter.]

Senator ALEXANDER. We have four votes at noon, so I am going to try to keep my questions brief, so Senators Dodd and Burr, if they have questions, will have a chance to ask them, and we will make as much as we can of the next 20 minutes.

Mr. Rudin, you mentioned you know 8,000 more students in Tennessee who could take the AP test. How do you know who they are?

Mr. RUDIN. We have tested 10th and 11th graders in Tennessee with the PSAT, the Preliminary Scholastic Aptitude Test, that about 3 million kids take across the country.

Senator ALEXANDER. Is that in the 8th grade or in the 10th grade?

Mr. RUDIN. In the 10th and 11th grade.

Senator ALEXANDER. They take the PSAT.

Mr. RUDIN. Take the PSAT. We have done a correlation study that shows, depending on your performance on the PSAT in math how likely you are to score a 3, 4 or 5 on the AP exam.

Senator ALEXANDER. Tennessee would be usually about 2 percent of the country, so it might be 60,000 Tennessee——

Mr. RUDIN. Roughly that many, right.

Senator ALEXANDER. And 8 of the 60,000, you would predict would score a 3?

Mr. RUDIN. With a strong likelihood of success, 3, 4 or 5 on the AP calculus test. Only 1,100 kids passed the AP calculus test last

year, but we project that an additional 8,000 could pass the AP calculus course and exam if they simply were offered it or took it. The problem is it is either not offered in their high school, or more likely, it may be offered but the students are not encouraged to take it, and, frankly, some may be discouraged from taking it.

Senator ALEXANDER. Mr. O'Donnell, last week I was with a professor from the University of Texas, Uri Treisman, who gave a paper. He is at Austin. He pointed out something I just did not know, and Senators Dodd and Burr I think will be interested in this. He pointed out that 13 States—the point of this comment is that our students can do well, that 13 States, in 1999, treated themselves as a country, and submitted themselves for the 8th grade Third International Math and Science Study, which is the best, most respected math and science international comparison I know about, and that Texas, whose sample contained more than 50 percent African-American and Hispanic students, performed at the significantly higher level than most European countries. Texas 8th graders in math and science in 1999 performed at a significantly higher level than most European countries.

You have been at this for a while. We just heard that at the present level of instruction there are 60,000 students in Tennessee, who take the PSAT, and 8,000 of those 60,000 could make an AP score of 3, 4 or 5. What are the chances of increasing the percentage of students who can succeed on an AP test to the level of 3, 4 or 5?

Mr. O'DONNELL. Our view is the teacher. The student, of course, has to go to a school that offers the exams, the courses, but the key is the teacher. A poor teacher cannot get those kids to pass AP, which is a college-level course, and an excellent teacher almost demands that they do.

We have a science and engineering magnet in the Dallas School System that produced, for 3 years in a row, more African-American and Hispanic passing grades in the calculus AP and BC than any other school in America. So they can learn, but it has to do with an outstanding teacher. That is what we look for. We try to motivate, and we try to give them the incentives and recognition that they deserve.

Senator ALEXANDER. Joshua, have you taken any AP exams yet?

Mr. TAGORE. No, but I think that my first AP exam is scheduled in May.

Senator ALEXANDER. Are they typically given to sophomores and freshmen? Do many sophomores and freshmen take the AP exams?

Mr. RUDIN. Most are given to juniors and seniors, but when you have an exceptional sophomore, they will take them as well.

Senator ALEXANDER. Joshua, what is your guess—you have obviously gotten yourself very well qualified in math and science. How many of your fellow students could do that if they tried?

Mr. TAGORE. I think all of them, all of them, because it is a matter of putting your mind to it.

Senator ALEXANDER. And, Mr. O'Donnell said he thought the teacher was the critical component in that. What is your opinion?

Mr. TAGORE. I think to some extent it is part of the teacher's role to encourage the students and to motivate them to be successful,

and then it is the students' part to feel that they can be successful and do what is right.

Senator ALEXANDER. Mr. Bement, as you look at the recommendations of the PACE Commission, do you see proposals that the National Science Foundation already is doing, and that ought to be modified or expanded, rather than adopt the proposals of the PACE Commission?

Mr. BEMENT. Yes, Senator. There are two programs that are in the PACE bill that closely parallel what we are currently doing. One is in Section 132, Recruiting and Training New Mathematics and Science Teachers, that closely follows our Noyce scholarship program, where we encourage undergraduate students in science and engineering to go on for a degree in education. We provide scholarships for that. In terms of years of service required after the degree is granted, they are very similar. I will not go into the details. We can provide that for the record.

The second program is section 191, the National Science Foundation Early Career Research Grants. We currently have an early career program. We call it career, but it focuses both on research and education because research and education are two sides of the same coin, as far as the Foundation is concerned. Again, there are some differences in qualifications, and on the use of the funds, but fundamentally, section 191 proposes no less than 65 grants. We already satisfy that. We are providing 375 career grants annually. The amount of funding is very similar. Section 191 proposes the grants be 5 years of duration and $100,000 a year, and that closely parallels what we are currently providing. As a matter of fact, a third of our awards actually exceed that minimum.

Senator ALEXANDER. Thank you. I am going the ask our subcommittee staff to work with you and make sure that our proposals are the most practical proposals. In other words, if what we should be doing is amending and enlarging existing programs rather than starting a new program, we ought to consider that.

Senator Dodd.

Senator DODD. Thanks very much, Mr. Chairman.

Let me go back to the first question the chairman asks. Actually, we were chatting here during your testimony. I am wondering if we cannot do a better job of identifying the Joshuas before junior and senior year. I am worried that we are letting kids slip. I mean we are not picking up earlier in the educational process the students who are capable of doing what Joshua is doing. I am going to ask you, even though, what you do is dealing more at the high school level. It worries me that we go K–8 and I am told over and over again that by the time a child is in the 3rd grade, that if they are slipping behind in reading and so forth, they are more likely to drop out. And yet, we know that many of these young people have more than the capabilities to perform, and yet we do not really determine who is capable until they get to that junior year in high school or senior year in high school.

It seems to me there just have to be thousands of kids out there, not millions of them, that could be performing at an AP level, and by the time we test them it is just too late, they have slipped out of the system, maybe they are dropping out or going to drop out, and they become kids we have to worry about because they are

going to live in a global economy where the skill level they have is just going to not give them much more of an opportunity than performing very menial tasks and jobs.

Maybe this is a question too for you, Mr. Johnson, at the Department of Education. I am looking at the budget numbers. If you have not heard from others on this committee, I presume you will at some point or another. We are talking all about this commitment to education, and I have to tell you—you are the one sitting here it is terribly disappointing to see the numbers in this budget. Hopefully, this committee and others will do a better job at getting some of these resource levels back up. But you heard Governor Hunt, you heard everybody else, this cannot be done on the cheap. What we are talking about here in this program, the PACE bill, is going to cost a lot. Yet I am dismayed when I look at what has happened to title I, what has happened to special education.

Here we are, it is the 21st century, and I do not know of anybody that pays any attention to this subject matter who believes that if this Nation ever portends it is going to be successful in this century and commit itself at the levels we are talking about here, education, we are just not going to make it. The Joshuas will, a couple of more will here, but the bulk of students sitting out there are not going to get that help if we do not do a better job at this thing. So tell me why we are not doing a better job, and how can we do a better job of identifying children earlier in this process than waiting until their sophomore or junior year to discover that they might be an AP student. How do we do that? Why can we not do that? Anyway, the question is open. Go ahead, Peter.

Mr. JOHNSON. Let me comment on that. You raised a couple of issues, the first dealing with why we are not doing a better job with students at the elementary level. This may sound counter-intuitive, but I think Josh put his finger right on it. The research suggests that even students who have not been terribly successful, when exposed to a rigorous curriculum experience, learn more, fail less. One thing that we have to do—and no child is clearly directed toward that—is to make sure that every single student has a rigorous curriculum experience throughout school, taught by the excellent teachers.

Senator DODD. You undercut No Child Left Behind by $15.4 billion, the No Child Left Behind Act. I voted for it. I think it was a good idea, but how can you possibly talk about it and then not fund the program?

Mr. JOHNSON. Well, we are doing several things. The actual expenditure on education over the past 5 years has increased, and the President and the Secretary have proposed a budget that actually targets what we think is the next stage of school improvement. The first round of money went to help States build assessment systems. I was State chief in Mississippi. Mississippi already had an assessment system grades 2 through 8 in reading and mathematics, and high school end-of-course tests. We took No Child dollars and built and offered to the schools of the State a diagnostic assessment program on demand. The teacher could call up an assessment for the class and get an analysis of strengths and weaknesses of that class, or an individual child, and suggestions as to

what to do to teach to the strengths and remediate the weaknesses. No Child was a big help to us in Mississippi.

That also leads to one other thing I want to say. Accompanying a more rigorous curriculum experience has got to be a comprehensive assessment program, both formative and substantive. We have got to have information that helps kids.

Senator DODD. I hear you, but you know what I am saying to you too.

Mr. JOHNSON. Yes, I understand.

Senator DODD. We have 30 some odd percent of teachers in a lot of our elementary schools who are not certified to teach what they are teaching in urban schools, not true necessarily in suburban schools. We are cutting back program after program because the State and local budgets are strapped trying to meet needs. We are talking about math and science here today, but we also understand the importance of other things that would be part of a curriculum of a child growing up things like music that can make a huge difference in mathematical development, by the way. We are falling behind in our national commitments, in my view, in this area, and I am just worried that we are missing the kids.

We are missing 8,000 in Tennessee alone that could have been AP students. You start multiplying that fact around the country, it seems to me we have a lot of work to do to close that gap.

Mr. JOHNSON. Correct.

Senator DODD. Peter, you wanted to make a comment.

Mr. O'DONNELL. I do. Laying the foundation program that we have developed starts in the 6th grade, and it will have the same diagnostic test and end-of-course assessment so that you will know how each of those students are doing, and you are moving them along a path toward AP.

Senator DODD. You are picking up a lot earlier in the process.

Mr. O'DONNELL. We are picking them up at 6th grade, not waiting until it is too late.

Senator DODD. Who else is doing this? Do you know of other States around the country that are doing anything like that besides you?

Mr. O'DONNELL. I do not know. We have the only one that I know of.

Senator DODD. Mr. Bement, do you want to comment on this?

Mr. BEMENT. I think one of the critical factors has to be setting expectations, and it has to be expectations set not by the teacher, not by the school, but by the community. You have to get the community engaged, and that is where the business sector does come in, because our experience indicates that when you get the business sector involved, when you get the professional societies involved, and they all aim at the same expectation, things really do improve.

Senator DODD. Let me ask you a quick question. We listened to Jim Hunt recommend that maybe the National Academy of Science ought to set some American standards and then incentivize our States in the math and science area. As part of the National Science Foundation, how do you feel about that and would the National Science Foundation be inclined to want to participate in something like that?

Mr. BEMENT. Let me say, Senator that over the years, both the National Science Foundation and the Department of Education together have sponsored most of the studies that have been conducted by the National Academies, and we clearly would want more of these types of studies to be conducted.

Senator DODD. Do you like the idea of having some American standards in math and science, or is that going too far in your view?

Mr. BEMENT. No, I do not believe it is going too far.

Senator DODD. Joshua, last with you, you answered the question, you said almost every other student. You are talking about the students in your present magnet school, the University of Hartford High School. What about students that you have known when you were in other schools and so forth? What is your impression about the number of other classmates you have had that may not be in the program you are in or would not get into it today, but could have if earlier identification of their abilities had been identified and someone had worked with them?

Mr. TAGORE. I think that a lot of students can do anything that they put their minds to, and I think that a lot of talent is wasted sometimes, but I think that if you encourage a student, then you can bring out the best in them.

Senator DODD. You said something to me when we were in Hartford the other day that I have not forgotten. You said to me one of the reasons you like being where you are in school today is because it is okay where you are to be smart. Remember saying that to me?

Mr. TAGORE. Yes.

Senator DODD. Tell me about what that means. Was it not okay to be smart in some of these other schools you were in?

Mr. TAGORE. Sometimes, yes. Sometimes you are——

Senator DODD. Why does that happen? What happens?

Mr. TAGORE. You are looked down upon as strange in some sense because you like to—because your passion is in the work, and you want to get insight from the teachers. I guess in other schools it is not accepted that much. But when you go to a school such as University High School, there are teachers with so much insight that you have to tap into, and it just helps you become a better student.

Senator DODD. And it is okay to be smart.

Mr. TAGORE. It is.

Senator DODD. I should have said at the outset, by the way, with my colleague from New Mexico and Pete Domenici, I thank you, Jeff. If it had not been for this Senator and Senator Alexander, we would not have had the study done and so forth, so we are talking about a subject matter today because two United States Senators decided to make a difference, and a guy from Tennessee decided it was worth putting in bill form, so, Jeff, I thank you very, very much.

Thanks, Mr. Chairman.

Senator ALEXANDER. Thank you.

Senator Burr.

Senator BURR. Mr. Chairman, I will be quick.

Secretary, it is great to have you here.

Mr. JOHNSON. Thank you.

Senator BURR. It's always good to have somebody from North Carolina on every panel.

[Laughter.]

I thank you for letting us put the Governor in front for a second, but you and I are used to having that happen.

Mr. JOHNSON. Absolutely.

[Laughter.]

Senator BURR. Mr. O'Donnell, thank you for your work.

Joshua, your insight has been incredibly helpful, and your understanding of how a brain works, I would love to spend some time with you because I am still trying to figure out some of the people I serve with up here, and how their brain works.

[Laughter.]

Senator DODD. You are making an assumption they have one.

[Laughter.]

Senator BURR. Just one question. I have heard every questioner ask the same question, and I have heard most of you respond, so I will throw it out there for anybody who would like to tackle it.

In Tennessee, 8,000 opportunities missed. But to legitimately say we missed it, we have to believe that there were a sufficient number of teachers with degrees to teach AP classes to 8,000 students in Tennessee alone. I do not believe that is the case, and if there were, there would not be any AP teachers left in the 49 other States, so it would be a study of what we had missed somewhere else. I think we are in agreement on that.

My question is can we use distance education to teach AP, and can we, at least in the short term, leverage the limited pool that we have of people who have that expertise to expand the opportunity, maybe not in the most preferred way, but certainly in a temporary way while we get there?

I will let all of you answer, but I want to make this comment. We here, and I think those of us in education, do not put enough credibility behind technology because we grew up at a different time. He does things with technology that we never dreamed about, we will never understand, and therefore, we assume that if designed, those on the other end will not utilize it to its capabilities, and I would tell you that it gets back to that expectation thing that I talked to Jim Hunt about. And he just confirmed it. Give them an opportunity. We cannot make them absorb it, but not providing them the opportunity is the only mistake we can make.

Mr. RUDIN. Senator, I think you have hit the nail right on the head. It is the teacher that is the issue, and getting a high-quality teacher trained. Let me just clarify one thing. When I talk about 8,000 students who can succeed, that is just AP calculus. In Tennessee alone you have another 4,000 students who could have passed AP physics, 10,000 in AP chemistry, 11,000 AP history. I can go through the whole thing. There are millions of students in this country who can succeed in AP courses if they are given the chance, if the course is offered, and if we can get a quality teacher in the classroom to teach it. So you are exactly right.

In terms of distance learning, we at the College Board, we are not in the business of actually running courses. We sponsor the AP program, but we know there are private companies, we know there

are colleges and universities who are offering AP courses online with some degree of success, and we encourage that.

One thing we do is we have an electronic professional development program for AP teachers, and about 300,000 teachers—which means a lot more than just AP teachers—are involved in this electronic discussion group so that they can exchange lesson plans, share ideas, exchange labs, and offer professional development online. I think you are exactly right, if we are really serious about ramping up AP access, and IB and other rigorous courses, we have to use technology much more effectively.

Mr. O'DONNELL. On the number of teachers, part of the National Academy report involves—part of that report, we are going to ramp up. We are not going to get all those AP teachers or pre-AP teachers in a year. It calls for a 4- to 5-year period to train the teachers that we will need in those disciplines.

The second thing is, our experience, and the person that runs our foundation in Texas, Greg Fleischer—he is here—used to use a distance learning, but it was really as a supplement. It was once a week, and they would go into those schools, and the teacher would have their students, and they would address aspects of problems they were dealing with in the course that week. So it was effective, but nothing will take the place of a good live-wire teacher, well prepared, in the classroom, but as a supplement, yes, and as best practices among teachers, yes. But I think it will not anytime soon take the place of a well-prepared teacher in a subject.

Senator ALEXANDER. Senator, we are about to vote, and I want to make sure Senator Bingaman has a chance.

Senator DODD. Mr. Chairman, the Secretary wants to respond.

Senator ALEXANDER. Excuse me.

Mr. JOHNSON. Just briefly, in the Competitiveness initiative there is a proposal to train AP and IB teachers and expand it, so it gets at that same issue.

Mr. BEMENT. May I make a brief comment?

Senator ALEXANDER. Dr. Bement.

Mr. BEMENT. Some of the results of our research indicates that AP programs are exceptionally important, but even in the earlier grades, it is turning out that students who excel in mathematics, also excel in science, also excel in reading, so there is an interrelationship or there is a coupling in the learning process.

Senator DODD. Music too.

Mr. BEMENT. That is broadly beneficial. Music as well. I am a music buff, so I agree with you.

Senator ALEXANDER. Senator Bingaman has really been the leader, along with Senator Hutchison, on advanced placement legislation. We will let him have the last word.

Senator BINGAMAN. Thank you very much. Let me thank all of you, and particularly commend Peter O'Donnell for his leadership on this, and I have admired his initiative in Texas for many years. As he knows, he briefed a group of us from New Mexico about what they are doing, and I very much appreciated that. I commend him. He is a good share of the reason why this is part of the President's initiative here, and we want to see it happen.

Let me just ask Secretary Johnson, I asked our Secretary of Education Spellings the other day—I stated my concern about how

there seemed to be a proposal by the administration to train 70,000 AP teachers, but I did not see any commitment to train pre-AP teachers such as the effort that is being made there in Texas with laying the foundation. She said, "No, no, that is part of it. We are going to train pre-AP teachers, as well as AP teachers." Do you know, is there anything concrete that the Department has done to sort of indicate how this would go about? I am just unclear as to what concrete steps the Department would anticipate taking to gear up the training of pre-AP teachers.

Mr. JOHNSON. We are in the process of putting all that together, but one of the things that clearly has to happen is the State level capacity for improving schools, if the dollars for that come through, that has a strong staff development component. The High School Initiative that is part of the President's proposal will give formula money to States, and they in turn could do competitive grants with local school systems, all targeted toward improving the high school experience and the middle school experience for after that. Then we have the Math Now for both middle school and elementary, both of which have professional development components.

Senator BINGAMAN. I guess what I am not clear on, also is it the plan of the administration to contract with nonprofits or with the College Board or with someone to do this training, or do you intend that the States gear up to do it? How does this happen?

Mr. JOHNSON. well, certainly working with the College Board, but other entities to also do the professional development for teachers, but certainly working with college boards is one of the things we do.

Senator BINGAMAN. As quick as you are able to sort of flush out how this would happen, I would sure be anxious to get some of the detail of it, because I would like to know the impact in my State and other States, and what kind of an opportunity this will result in for people. I think that is important.

One other issue Senator Burr asked. How do you get the maximum benefit from the pool of qualified teachers we now have? I remember in the briefing, Mr. O'Donnell, that you gave us there in your offices, you had circuit riders for some of the small school districts. That would be a tremendous help in my State. Could you describe that very briefly?

Mr. O'DONNELL. Yes. We have pilot programs with our small school districts. They cannot afford to hire or get the talent for an AP teacher, so we came up with a plan to have an AP calculus teacher and an AP English teacher, and we call them circuit riders because they will do four schools. They will go to each of those schools and teach the AP class. Now we are going to push that down to the pre-AP, but the circuit rider thing has been well received.

Senator BINGAMAN. It seems to me, Mr. Chairman, that is something which unfortunately, the walls that are built up around each school board and each school district sort of get in the way of that. But in my State, we have a lot of rural school districts, and if we could figure out a way to fund the salary of these circuit riders——

Mr. O'DONNELL. Well, the four districts were splitting the cost, and it makes it affordable.

Senator BINGAMAN. That is part of the solution to getting some of these courses taught even before we get the full complement of teachers that we need to do it.

Let me ask Dr. Bement, I am concerned that the budget proposes pretty drastic cuts in some of your programs, particularly this MSP program, Math and Science Partnership Program. You have one. The Department of Education has a Math and Science Partnership Program in addition. But yours has been going down in budget very substantially, and according to what I have here, it went from 104 million in 2004 to what is proposed for next year is 46 million. That does not look to me like a ringing endorsement by the rest of the administration of what you folks are doing. How do you explain this? Is this something you are trying to get out of this business?

Mr. BEMENT. No. The role of the Science Foundation is to really do the research and to evaluate the research through intervention, to understand what works. We work closely with the Department of Education in trying to make what works work more broadly through implementation. So there is the research and discovery role, there is also the implementation role. In order to get more impact across this whole area of education, we have to work together. We have to establish a partnership.

The funding in the Math and Science Partnership within the foundation still carries resources that will allow us to continue to collect data, to evaluate the data, to synthesize it and also to disseminate it, and to share it with the Department of Education. That cooperation transcends what goes on in Washington, because over two-thirds of our grantees in Math and Science Partnership are also partnering with the coordinators of Math and Science Partnership at the States, supported by the Department of Education.

What we are really trying to do is to get more dissemination. We are trying to build a brush fire. We are trying to broaden the lessons that we have learned, and the best practices that we have learned through the research and the interventions that we have carried on over the last 4 years, since 2002.

Senator BINGAMAN. Mr. Chairman, let me just indicate to you and Senator Dodd that I hope when the budget process begins around here, we can go ahead and add some money. I hate to see the National Science Foundation funding for education initiatives cut in the way it is proposed to be cut in this budget, so I hope we can correct that.

Thank you again for having this hearing, and thank you all for being here.

Senator ALEXANDER. Let me thank the witnesses and the staff and the large number of Senators who came by today. We have completed 2 days of hearings now on eight provisions from the National Academy of Science's recommendations for how we keep our advantage in science and technology. We heard good suggestions. We have gained some understanding. We have talked to Dr. Bement to make sure that we do not duplicate programs, and wherever we can, we strengthen and broaden programs. We have heard from Governor Hunt that he enthusiastically supports all of the provisions of the act. And, Joshua, we especially appreciate

your coming down, and we ought to have a hearing once a year just to watch your progress. I think we would all enjoy that.

Senator DODD. Here is his dad right over here.

Senator ALEXANDER. I am sure his father has had a lot to do with his success thus far.

Where we hope to go now is to make our recommendations from this subcommittee to the full HELP Committee. Senator Dodd and I will work together on doing that. Then we hope that our full committee will look not only at these provisions from the last 2 days, but the other provisions from the PACE Act that have been referred to this committee, get them to the floor.

I know the Energy Committee is planning to do that with eight provisions that were referred to it. Then whatever we do in our full committee will go to the Commerce Committee for 30 days. The Finance Committee has three provisions from the PACE report, and we are counting on the leadership, when all this is spread out, to pull it back together and give us a chance to approach this as we started, which was the question: how does our country maintain its advantage in science and technology over the next 10 years so we can keep our jobs from going overseas, so we can have the brain power we need to win the war on terror, and to have energy independence and all the other things we hope to do as a country.

Each of you have made a tremendous contribution to that. If you have other comments you would like to make, we would like to have them within the next week so we can include them in our work.

Thank you, Senator Dodd. Do you have any further comments?

Senator DODD. No, just to thank you and to thank our panelists as well. This is one of the reasons I like serving with Lamar Alexander, is he likes big ideas, and too often we spend too much time on marginal issue. This is the heart of it. Again, I point to that language in the summary, the abruptness of change that can occur if we allow this to slip. We may not get it back. The world is such today that with the click of a mouse, you can be in touch with anybody anywhere in the world to provide whatever data or information we need. And we had better be a part of that. We want when those mouses get clicked around the world, we want to be tying into a Web site that is located in the United States with people like Josh and others who are answering the questions and doing the work.

That is not going to happen. It does not happen miraculously. It never has. It was a Congress in 1860, during the Civil War, that passed legislation that created the Morrill Act, the land grant colleges. It was a Congress before the end of World War II that established the GI Bill. It was a Congress before they did anything else in 1789, it was the Northwest Ordinance, which set aside public lands for education. There has been a 218 year commitment in this country to the excellence of education. Thomas Jefferson said it better than anybody I have ever heard, at the beginning of the 19th century, any Nation that ever expects to be ignorant and free, expects what never was and never possibly can be. And if that was true in 1804, believe me, it is true in 2006.

So this is an issue we cannot waste any time on, and I am thrilled to be a part of this effort with Lamar Alexander, and Jeff

Bingaman, and Pete Domenici, and many others who care about it, and your participation has helped us today.

Senator ALEXANDER. Thank you. The hearing is adjourned.

[Additional material follows.]

ADDITIONAL MATERIAL

RESPONSE TO QUESTIONS OF SENATOR ENZI BY PETER O'DONNELL, JR.

Question 1. What role does philanthropy play in strengthening math and science education throughout the K–12 system? How can States and districts take advantage of the resources available to them through philanthropic organizations?

Answer 1. Philanthropy can support significant improvements in teaching and learning. Many donors want to improve public education. Businesses know that the strength of their future workforce depends on the quality of public schools. But they do not know where to place their bets in public education.

The education enterprise must become more accountable to receive more private support. Donors respond to data. They will support K–12 programs that have a proven track record. The academic outcomes must be measurable and documented; and the programs must be pegged to high standards and expectations.

An example of how philanthropy works to improve math and science in public schools is Advanced Placement Strategies, Inc. (APS), a nonprofit organization that operates in Texas. It is run by master teachers and supported by private funds. APS was established in 2000 to train the teachers and manage the Advanced Placement Incentive Program in 10 high schools in Dallas. At that time, it had only two donors—a private foundation to underwrite its operating budget and the Texas Instruments Foundation to underwrite AP incentive programs in the schools. Today, APS has 52 private partners who support AP and pre-AP programs in 69 school districts in Texas. These districts enroll 42 percent of total public school enrollment in Texas. APS is currently training 800 AP teachers of math, science and English and 7000 pre-AP teachers in grades 6–11 in math, science and English.

APS operates by 3-way contracts between the donor, the school district and APS. This not only shares the financial burden, it also lets the school know that the local community supports its AP program. The contract requires the district to report data to APS which analyzes it and reports results to the donors on a regular basis. Donors are asked to make 5 year commitments so the program will take hold in a school and grow. Incentives are funded by the private sector. Business knows well the value of incentives to reward performance and responds to incentive programs to reward academic performance. Paying incentives with private funds also has avoided any problems with teachers' unions in Texas.

As schools evaluate the success of their incentive programs, more school funds are being allocated to support AP teachers, as well as to pay the full cost of training pre-AP teachers and purchasing the materials and laboratory supplies they need.

The Texas experience demonstrates that a nonprofit organization, governed by a small board of philanthropic citizens and managed by outstanding, very experienced teachers, can bring together schools and private donors in pursuit of common goals. It is an implementation vehicle that will put philanthropic resources to work to improve academic performance in our schools. It allows a State to scale up quickly, while maintaining quality.

Question 2. How does increasing the number of advanced placement courses in a school impact the achievement of all students within that school?

Answer 2. In most schools, AP teachers teach AP students half the time and regular classes the rest of the time. Principals tell us that AP changes the academic climate of the entire school. AP teachers bring a culture of high standards and high expectations to their schools that positively influences other teachers so that all students begin to benefit from better teaching of content and higher expectations.

The impact is even greater in schools that offer pre-AP courses beginning in the 6th grade. Getting students into the AP pipeline early gives them confidence that they can master advanced math and science courses in high school and puts a focus on the important goal of graduating both from high school and from college.

An investment today to train one AP teacher or one pre-AP teacher, when coupled with incentives based on academic performance, keeps on providing returns for that school and its students for many years to come.

Question 3. Finding highly qualified science and math teachers is often a problem for urban and rural schools. What can be done to retain teachers trained in the advanced placement program in difficult to staff schools?

Answer 3. The short-term solution to recruiting and retaining teachers in difficult-to-staff schools is financial incentives—incentives to attend quality training institutes, incentives for extra work outside regular school hours (tutoring and prep sessions), and incentives based on their students' performance on AP exams.

AP teachers tend to have high job satisfaction. Even though teaching AP requires hard work and long hours, teachers in low-performing schools feel rewarded by seeing their students learn advanced material and go on to win scholarships and acceptance to universities.

The Dallas AP incentive program offer examples of the long-term benefits of incentives to retain good teachers in inner city schools. Dallas is the 12th largest urban district in the country. It has 93 percent minority enrollment and 82 percent of its students are economically disadvantaged. Many of its 28 high schools are considered to be "low-performing." However, teachers who were eligible to retire have not retired because their AP incentive payments, which are added to their regular salary, also serve to increase their retirement benefits. Even more important, several Dallas AP incentive schools are beginning to hire their former students as AP teachers. These newly-degreed teachers are eager to return to their old high school to teach, knowing they will be enthusiastically supported by their former AP teachers. When I testified before the Subcommittee on Education on March 1st, I distributed a series of charts showing results of the AP incentive program in Dallas. I have attached a copy for your information.

Our country's long-term solution is contained in the first recommendation of the National Academy "Gathering Storm" report, namely to vastly improve the teacher corps by attracting at least 10,000 of our best college graduates to the teaching profession each year. The foundation for a scientifically literate workforce begins with developing outstanding K–12 teachers in science and mathematics in numbers sufficient to serve all our schools.

RESPONSE TO QUESTIONS OF SENATOR JEFFORDS BY PETER O'DONNELL, JR.

Question 1. Both national and international tests continually show that U.S. students do well through the 4th grade and then a decline begins. The decline becomes worse between grades 8 through 12. What are your recommendations as to how we can specifically improve grades 5 through 8 in regard to math and science instruction?

Answer 1. The reason for the decline is that after the 4th grade in the United States the number of new science and math concepts introduced is very low. Students in middle school continue to add, subtract, multiply, divide and tackle word problems. Concepts of algebra, geometry and functions are ignored until the students reach 8th and 9th grades. It is not that algebra is so difficult, but without early preparation students can be overwhelmed by large numbers of new concepts being introduced. We know that elementary students can handle linear equations, basic geometric concepts and chemical reactions. But teachers are not prepared to teach the content. Textbooks spend too much time on repetitive drill. And expectations for our middle school students are disturbingly low.

The solution is pre-AP classes in grades 6–11 with an integrated curriculum taught by highly trained teachers. Better training of teachers already in the classroom is essential. In Texas, master AP and pre-AP teachers developed a program called, "Laying the Foundation." Since there are no pre-AP textbooks in math and science, Laying the Foundation provides the curriculum, benchmarks, assessments and training to teach the content and analytical skills to begin preparing students in the 6th grade to master advanced courses in the 11th and 12th grades. Each lesson is aligned to the National Science standards and to AP topics in science and math. When fully deployed in the country's middle and high schools, pre-AP will provide an enormous boost for all students by giving them an early start on learning essential math and science concepts at increasingly difficult levels as they progress through each grade.

Question 2. The New England Association of Schools and Colleges has found that one of the primary reasons this Nation's students appear to do poorly after 4th grade in math and science on international tests is that the United States sets up math and science curriculum completely different than most other Nations. For example, in the United States calculus is usually taught in 12th grade and in other countries, it is taught in earlier grades. Thus, the international tests could be comparing apples to oranges. What are your thoughts on this?

Answer 2. While I am not qualified to offer as expert an opinion on this matter as would an organization such as ACHIEVE, we do know that the U.S. curriculum, taught by well trained teachers, should introduce critical science and mathematics concepts as early as possible. Perhaps another question is whether expectations of parents and educators are driving earlier success in other countries.

At the Science and Engineering Magnet School in Dallas, 36 sophomore students, including 20 minority students, took the AP calculus exam. This exam covers the

first semester of freshman calculus in college. All 36 students passed and 50 percent scored a "5", the highest possible grade on an AP exam. When outstanding teachers have high expectations, students rise to the challenge, even as early as the 10th grade.

I am aware of one research report which shows that Advanced Placement enables U.S. students to successfully compete internationally in math and science. According to a study at Boston College, AP calculus students scored higher than students in every other country on the TIMSS math problems, compared to the U.S. as a whole which was second from the bottom. Our students who passed an AP physics exam scored above all but one country, whereas the U.S. scored at the very bottom.

Achievement of 12th Grade Students on the International Mathematics and Science Study (TIMSS) Compared to US AP Calculus and Physics Students

Mathematics	Average Achievement
US AP Calculus students scoring 3, 4 or 5	598
US AP Calculus students	573
France	557
Russian Federation	542
Switzerland	533
Australia	525
Cyprus	518
Lithuania	516
Greece	513
Sweden	512
Canada	509
International Average	*501*
Italy	474
Czech Republic	469
Germany	465
United States	442
Austria	436

Physics	Average Achievement
Norway	581
US AP Physics students scoring 3, 4, or 5	577
Sweden	573
Russian Federation	545
US AP Physics students	529
Germany	522
Australia	518
International Average	*501*
Cyprus	494
Latvia	488
Switzerland	488
Greece	486
Canada	485
France	466
Czech Republic	451
Austria	435
United States	423

In a study conducted by the TIMSS International Study Center at Boston College, 1995 TIMSS math and science questions were administered to US AP students in 2000 with the results shown above

I hope this information is helpful to you. Please let me know if you would like clarification of any of my comments or have further questions.

RESPONSE TO QUESTIONS OF SENATORS ENZI AND JEFFORDS BY ARDEN BEMENT, JR.

PARENTAL INVOLVEMENT IN EDUCATION

Question 1. Parents play an important role in their children's education. If they don't see a crisis over science and math, it may be difficult to garner support for improving science and math education throughout the country. Do you see a problem with parental engagement? How could the National Science Foundation address the issue?

Answer 1. The importance of parents is reflected in nearly all NSF/EHR programs focusing on formal K–12 and informal science education. However, we are aware that while parents can be powerful allies for science and mathematics programs in schools, recent studies show that they are generally satisfied with the quality of education received by their own children, thinking that well-documented national problems must be elsewhere. In addition, parental involvement in schooling differs significantly by demographic group.

A growing number of projects are shedding light on issues surrounding parental involvement and developing strategies for engaging parents. Examples:

• *Learning to Work with the Public in the Context of Local Systemic Change* (ESI–9980602). The project developed strategies for teaching parents how to recognize quality mathematics programs; experience mathematics in meaningful ways; engage in ongoing discussions in mathematics education; and better understand the urgent need to implement high-quality mathematics programs.

• *Community Ambassadors in Science Exploration* (*CASE*) (ESI–O337266) encourages appreciation and understanding of science among underserved families. Research indicates that the family learning approach is uniquely capable of not only

developing support for science learning in schools, but also in creating a context that reinforces science learning in out-of-school settings.

• In general, informal science education projects, including television shows such as *ZOOM* and *PEEP*, IMAX films, and community science projects, are designed not only to motivate and educate children about science and technology, but also to involve parents in shared education activities and to raise their awareness of the importance of science education.

• All comprehensive, multi-year curricula as well as some of the instructional modules developed with NSF support now require development of companion materials designed to help parents, among others, understand the philosophy and instructional strategies.

NSF will continue to pursue a multi-pronged strategy to engage parents through its formal and informal education programming, including development and evaluation of effective strategies as well as research around factors critical to their success in diverse settings. NSF intends to strengthen and expand its efforts to disseminate these successful strategies to broad audiences.

NSF/DEPARTMENT OF EDUCATION COORDINATION

Question 2. How is the NSF coordinating with the Department of Education to align the goals of Math & Science Partnerships with the No Child Left Behind Act?

Answer 2. The Math and Science Partnership (MSP) program at NSF is a research and development effort that supports innovative partnerships between higher education—especially disciplinary faculty in mathematics. The sciences and engineering—and local school districts to improve K–12 student achievement in mathematics and science—MSP projects are expected to both raise the achievement levels of all students and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations. Through these goals and such other key features as teacher quality, the MSP program at NSF directly supports the work of the Department of Education (ED) and the *No Chid Let Behind Act* (NCLB).

Coordination with ED in aligning the goals of MSP with NCLB occurs at multiple levels: at the **agency level**, at the **program level**, and at the **project level**. At the **agency level**, Dr. Arden Bement (Director of NSF) works to coordinate with ED and has met personally with ED Secretary Margaret Spellings to discuss NSF and ED's shared sense of mission to identify and implement high quality programs that will result in improvements in student performance. In addition, a cross-agency "Tiger Team" meets for discussion of and coordination of our common efforts, including the MSP. The members of the "Tiger Team" include Dr. Donald Thompson (Acting Assistant Director, EHR, NSF) and Dr. Henry Johnson (Assistant Secretary for Elementary and Secondary Education ED), as well as their peers from other Federal Agencies with an interest in mathematics and science education. In addition to the "Tiger Team," the MSP program staffs at NSF and ED meet regularly to plan and coordinate common MSP efforts across the two agencies.

Coordination with ED in aligning the goals of MSP with NCLB occurs at **both the project and program levels**. As MSP work has progressed and deepened, coordination has grown at the **project level** between projects/partners funded by NSF and those connected with the various State Departments of Education and with State MSP efforts. State Departments of Education, for example, are partners in many NSF-funded Partnerships:

NSF Grantee/Lead Organization	State Department of Education
University of North Carolina General Administration	North Carolina Department of Public Instruction
University of Kentucky	Kentucky Department of Education
Duke University	North Carolina Department of Public Instruction
The Vermont Institutes	Vermont Department of Education
Hofstra University	New York State Education Department
University of Puerto Rico-Rio Piedras	Puerto Rico Department of Education
University System of Georgia	Georgia Department of Education

Almost **two-thirds of NSF's funded Partnerships report direct collaboration in the field with State MSPs**. This collaboration takes many forms, from full inclusion of new districts supported by ED/State MSP dollars into the work of an existing NSF/MSP, to an NSF/MSP project's intellectual input that guides specific aspects of the work of a State MSP site.

At the **program** level, NSF's MSP-RETA (Research, Evaluation and Technical Assistance) component supports the development of tools and other deliverables that inform and assist both NSF's and ED's Partnerships. These include, for example, tools to assess teacher's knowledge of mathematics content and how this content is used in teaching mathematics, with particular focus on upper elementary and middle school algebra and geometry. Tools of this type have not previously existed and are being used in both NSF's and ED's MSPs to inform and assess their work.

Other tools that address the needs of both NSF's and ED's MSP sites are being developed in the NSF-funded Partnerships themselves, an example is the collaboration in the *Appalachian Mathematics and Science Partnership* with the Kentucky Department of Education to develop an innovative system that helps school principals identify the instructional methods teachers use, spot instructional problems and make decisions that inform teacher development, towards a goal of improved student achievement.

The work of the MSP-funded projects at NSF is being widely disseminated to ED and to its MSPs in the States through NSF's *MSPnet* and NSF project Web sites, and in face-to-face meetings. Recent examples include:

• At the October 2005 meeting of ED's State MSP Coordinators, NSF hosted ED's MSP Coordinators from 46 States and shared with them the work, tools and instruments from 13 of NSF's MSP-funded Partnerships and RETA projects.

.• NSF has provided the State MSP Coordinators access to and dedicated space on NSF's *MSPnet*, the NSF-funded electronic community for sharing resources, research and events among MSPs.

• At annual meetings of the NSF MSP Learning Network Conference [MSP Principal Investigators and project leaders], selected sessions are always jointly developed with and led by ED and/or their State MSPs.

• NSF's MSP program staff and funded Partnerships/RETAs are participating in and disseminating their work at each of ED's three regional MSP meetings in spring 2006 (in Orlando, Seattle and Boston).

MATH AND SCIENCE INSTRUCTION IN GRADES 5–8

Question 3. Both national and international tests continually show that U.S. students do well through the 4th grade and then a decline begins. The decline becomes worse between grades 8th through 12th. What are your recommendations as to how we can specifically improve grades 5 through 8 in regard to math and science instruction?

Answer 3. NSF recognizes that the middle grades are critical. In 2000, responding to the insights from the Third International Mathematics and Science Study (TIMSS, 1995) and contemporary research, NSF issued a special middle-school program solicitation (NSF 00–80) that called for curriculum that embodied a strategic vision of what students should know and be able to do; science instruction that expected students to study more demanding science content and increase the breadth and scope of subsequent study; and a focus on instruction related to complex concepts delivered with emphasis on deeper understanding of fundamental ideas. The 4 multi-year, comprehensive curricula being supported will have major long-term pay-off for the country. Examples:

• *Investigating and Questioning our World through Science and Technology* (*IQWST*) (ESI–0439352). *IQWST*, a curriculum for grades 6–8, is currently being developed and field-tested. These materials are organized around driving questions that provide a context to motivate students as they use their knowledge and skills in scientific practices (e.g., modeling, designing investigations, explanation and argumentation, data gathering, analysis and interpretation), While the materials are relatively new, preliminary results from their use in pilot classrooms have been very promising with increases in both basic concept knowledge and increased ability for students to construct scientific explanations.

• A revised *Connected Mathematics* (*CMP*) curriculum released in 2005 (ESI–9986372) is helping students, grades 6–8, develop understanding of important concepts, skills, procedures, and ways of thinking and reasoning in number, geometry, measurement, algebra, probability, and statistics. Early indications are that it has a 25 percent market share. Evaluation results highlight two main points:

• *CMP* students do as well as, or better than, non-*CMP* students on tests of basic mathematics skills. And, *CMP* students outperform non-*CMP* students on tests of problem solving ability, conceptual understanding, and proportional reasoning.

• Examples of student work demonstrate that *CMP* students can use basic skills to solve important mathematical problems and are able to communicate their reasoning and understanding.

Another critical issue for the country is the preparation of teachers. Given that many middle grades mathematics and science teachers tend not to have strong content preparation in their teaching area, it is important that preparation programs in both disciplines be strengthened and that current teachers be assisted in gaining new knowledge and skills. For the past 3 years, under the Teacher Professional Continuum (TPC) program, NSF has funded several research studies that are increasing our understanding of issues related to the education, retention, and development of highly trained middle grades science teachers.

Out of school activities are also important for middle grades students. Information Technology Experiences for Students and Teachers (ITEST), grades 7–12, and the soon-to-be-released NSF Academies for Young Scientists (NSFAYS), grades K–8, will develop demonstration models of how in-school and out-of-school science and mathematics experiences can work hand-in-hand to excite and prepare students, especially those at the middle grades level. Opportunities provided by supported projects should improve student performance in rigorous high school courses and potentially lead to advanced study and potential careers in scientific disciplines.

U.S. STUDENT PERFORMANCE ON INTERNATIONAL TESTS

Question 4. The New England Association of Schools and Colleges has found that one of the primary reasons this Nation's students appear to do poorly after 4th grade math and science on international tests is that the U.S. sets up math and science curriculum completely different than most other Nations. For example, in the U.S., calculus is usually taught in the 12th grade and in other countries, it is taught in earlier grades. Thus, the international tests could be comparing apples to oranges. What are your thoughts on this?

Answer 4. Comparing student achievement at the end of secondary school is more complex than comparing elementary students because the mathematics content may differ between countries and also because the percentage of students still in school may differ by age 18. For that reason, only 2 international comparisons of mathematics have been attempted (in 1982 and 1995). The 1995 TIMSS 12th grade study made an extensive effort to make the comparisons of populations as similar as possible. Yet, the achievement of U.S. students compared with the 16 countries that agreed to participate in the study was very low.

The 12th grade study was intended to be a study of mathematics literacy at the end of secondary school and thus all students were tested at a level of mathematics that was appropriate for high school students. If the results are disaggregated and the 14 percent of U.S. students who took advanced mathematics are compared to similar students in other countries, the U.S. student ranking is as low as it is for all students in the study (see *Mathematics and Science Achievement in the Final Year of Secondary School*, Table 6.1 (attached) and available at http://isc.bc.edu/timss1995/TIMSSPDF/C.admath.pdf (page 146 (20 of 57)). However, for the U.S. students who took AP calculus, the performance rating was 513 or just above the international average of 500. This finding calls into question the argument that the comparisons are not fair.

The TIMSS study group published *A Study of U.S. 12th Grade Mathematics and Science Achievement in an International Context* in 1998. The authors noted that the average age of students in many high performing countries (Denmark, New Zealand, Norway and Sweden) was higher than in the United States and that it might account for some of the achievement differences.

Table 6.1

Achievement in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Country	MTCI	Advanced Mathematics Content Areas Mean Achievement Scale Scores: Numbers and Equations (17 items)	Calculus (15 items)	Geometry (21 items)
Canada	16%	● 512 (3.9)	● 503 (3.6)	● 499 (3.6)
[a] Cyprus	9%	● 519 (5.7)	▲ 561 (5.2)	▲ 517 (4.9)
Czech Republic	11%	▼ 460 (11.7)	▼ 446 (9.7)	● 494 (9.8)
France	20%	▲ 548 (4.1)	▲ 560 (3.0)	▲ 544 (3.8)
[1] Germany	26%	▼ 457 (5.0)	▼ 454 (4.4)	● 487 (5.5)
[1] Greece	10%	▲ 539 (7.2)	▲ 538 (7.3)	● 498 (8.7)
[1] Lithuania	3%	▲ 547 (2.8)	● 498 (2.5)	▲ 519 (2.8)
[2] Russian Federation	2%	▲ 555 (8.8)	▲ 537 (9.1)	▲ 548 (8.2)
Sweden	16%	▲ 523 (4.7)	▼ 480 (4.4)	● 492 (4.4)
Switzerland	14%	● 514 (5.3)	● 512 (5.7)	▲ 547 (4.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (See Appendix B for Details)				
Australia	10%	● 517 (9.4)	● 530 (11.7)	● 496 (12.5)
[b] Austria	33%	▼ 412 (7.4)	▼ 439 (6.5)	▼ 462 (7.9)
[1] Italy	14%	▼ 480 (9.2)	● 530 (10.4)	● 480 (9.5)
United States	14%	▼ 409 (5.3)	▼ 450 (4.1)	▼ 424 (5.1)
Countries With Unimproved Sampling Procedures and Low Participation Rates (See Appendix B for Details)				
Denmark	21%	● 504 (2.7)	● 508 (3.3)	▲ 522 (3.1)
Slovenia	75%	● 491 (9.9)	▼ 471 (6.8)	▼ 476 (7.6)
International Average		501 (1.7)	501 (1.7)	500 (1.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

▲ = Country average significantly higher than the international average for the scale

● = No significant difference between country average and international average for the scale

▼ = Country average significantly lower than the international average for the scale

[a] See Appendix A for characteristics of students sampled.

[1] Met guidelines for sample participation rates only after replacement schools were included (see Appendix B for details).

[2] National Desired Population does not cover all of International Desired Population (see Table B.4).

[b] National Defined Population covers less than 80 percent of National Desired Population (see Table B.4).

( ) Standard errors appear in parentheses. Because results are reported to the nearest whole number, some totals may appear inconsistent.

RESPONSE TO QUESTION OF SENATOR ENZI BY ASSISTANT SECRETARY JOHNSON

Question 1. The President's American Competitiveness Initiative proposes new Federal support to improve the quality of math, science, and technology education in our K–12 schools. The initiative includes a number of new and expanded programs including Math Now for elementary and middle school students. What spe-

cific plans are being made to address improving science education at the elementary and middle school levels?

Answer 1. Math skills are the foundation for learning science, so strengthening math instruction is fundamental to improving science education. After we lay the foundation with math, we hope to build on that success with a science panel.

Also, the Academic Competitiveness Council, established by the Deficit Reduction Act of 2005, will improve the quality of evaluations of all Federal Science, Technology, Engineering, and Mathematics (STEM) programs, with a focus on examining whether they are consistent with the principles of No Child Left Behind.

And the Adjunct Teacher Corps will create opportunities for qualified professionals from outside the K–12 educational system to teach secondary-school courses in the core academic subjects, with an emphasis on mathematics and the sciences.

RESPONSE TO QUESTIONS OF SENATORS ENZI AND JEFFORDS BY TOM RUDIN

Question 1. What role does philanthropy play in strengthening math and science education throughout the K–12 system? How can States and districts take advantage of the resources available to them through philanthropic organizations?

Answer 1. Philanthropy can and does play an important role in the process of strengthening math and science education, and some States and districts are taking advantage of these private funding opportunities. Much more can be done, however, to attract philanthropic dollars to mathematics and science education reform.

The College Board, for example, has secured grants to support the development and implementation of SpringBoard, its Pre-AP program in mathematics, from the following foundations: GE Foundation, Toyota Motor Company Foundation, National Science Foundation, and Ford Motor Company. Indeed, at this moment, the GE Foundation and Ford Motor Company are supporting Pre-AP and AP expansion initiatives in Erie, Pennsylvania, and Lansing, Michigan, respectively.

The Bill and Melinda Gates Foundation has also funded a major College Board Initiative called *College Board Schools*. We are pursuing the development of schools comprising grades 6–12 that have as their goal every student's successful completion of two or more AP courses. Five College Board Schools are operating now in New York City, and at least 12 more will open in the New York area within the next 2 years. At least 10, and possibly more than 100, additional Gates-sponsored schools could open in States and districts across the Nation over the next 5 years. These schools can be a model for other public schools across the country.

The Dell Foundation has recently funded an initiative of the National Governors Association in which the NGA has awarded grants of $500,000 to six States for AP expansion, with States required to provide a match of equal dollars. These six States—Wisconsin, Nevada, Alabama, Kentucky, Georgia, and Maine—are all pursuing major AP initiatives that focus on reaching traditionally underrepresented student populations. Actually, the approach NGA has taken—requiring a $1 match from the State for each $1 dollar awarded through the grant, and requiring States to submit a comprehensive plan for statewide AP expansion—maybe a model that you could consider for the structure and operation of the AP math and science provisions of PACE. We would be happy to talk further with you about how NGA developed the model, and the College Board is an integral partner in the operation of that program.

Other foundation and corporate entities, including Intel and other high-tech firms, have recognized that the future workforce needs better training and education, especially in the STEM (science, technology, engineering, and mathematics) fields. Those foundations typically invest in programs at the school or district level, but could possibly be encouraged to make investments in States or across consortia of States.

States and districts can take advantage of these philanthropic opportunities in several ways:

- Pursue State funding directly with foundations and corporate entities, with the aim of securing matching funds (to State and Federal investments) that are directed toward improving mathematics and science teacher quality—and that can be used to support incentive payments to teachers and schools that are committed to expanding student participation and performance in AP courses.
- Establish partnerships with national organizations (such as the NGA, the College Board, and others) and jointly pursue foundation funding to support a specific STEM initiative—such as the NGA-Dell model cited above.
- Develop State collaboratives in which States and philanthropic organizations (both foundations and corporations) establish a pool or "bank" of resources from which to draw to create national math-science initiatives such as AP and Pre-AP professional development programs, teacher internships, and so forth.

• Use non-traditional corporate support—for example, current and retired scientists and engineers who become "scholars in residence" in high schools with few or no advanced teachers of science and mathematics, and who teach two or three advanced-level courses.

Question 2. How does increasing the number of Advanced Placement courses in a school impact the achievement of all students within that school?

Answer 2. School superintendents and principals increasingly recognize the value of AP as leverage to increase achievement for all students—to serve as the tide that lifts all boats. They have discovered that the more AP teachers there are in a school, the more rigorous and challenging the curriculum becomes in AP and non-AP classes alike. Further, because most AP teachers only teach one or two AP classes, and three or four non-AP classes, many non-AP students benefit from the enhanced training that AP teachers receive.

The influence of AP courses throughout a school, and the growing recognition of the power of vertical teaming, was illustrated in a recent survey of AP Biology teachers. More than half the teachers (59 percent) surveyed said that they are encouraged to coordinate the content of their courses with other teachers in their department.[1]

A new study from the National Center for Educational Accountability suggests that one of the important values of AP can be the drive to improve the academic preparation of all students prior to their enrollment in AP courses:

To improve their college readiness outcomes for [low-income] students, school districts need to approach "Advanced Placement" not as a special set of courses for their already well-prepared students, but as a comprehensive program to prepare large numbers of students, starting in the early grades and including disadvantaged students, to be able to do college-level work before they leave high school.[2]

Evidence from the State of Florida and Charlotte-Mecklenburg (North Carolina) Public Schools illustrates the connection between an expanded AP Program and enhanced student achievement throughout a State and school district. Through a partnership with the College Board, Florida has undertaken a number of initiatives aimed at increasing the college readiness of its student population—including a major AP expansion drive. The results of Florida's efforts since the inception of this initiative in 2000 include the following:

• AP participation increased by 125 percent from 2000 to 2005.
• Minority AP participation increased by 128 percent from 2000 to 2005.
• Minority SAT participation increased by 65 percent from 2000 to 2005.
• Minority SAT verbal scores rose by 1 percent, even as 65 percent more students were taking the test.
• SAT participation by African-American students increased by 47 percent from 2000 to 2005.
• The average SAT math score for African-American students increased by 2 percent.
• SAT participation by Hispanic students increased by 84 percent from 2000 to 2005.

Approximately 7 years ago, the Charlotte-Mecklenburg Schools (CMS) launched a major commitment to increasing academic rigor and improving the rate of college-going among its students, and AP expansion was a major part of that effort. Among the program components implemented by the district were the following:

• AP Potential (testing students with the PSAT/NMSQT to identify strong candidates for AP success).
• Pre-AP teacher professional development program implemented and required.
• Strong teacher AP professional development program implemented.

The results of the CMS initiative include the following:

• Minority participation in AP has risen by 56 percent since 2000.
• The percentage of minority students scoring 3 or higher on AP exams has increased by 5 percent.
• The number of African-American students receiving a score of "at or above expectations" (3 or 4) on the State algebra end-of-course assessment has risen by 6.4 percent. For the first time, over half of African-American students (55.4 percent) passed the exam.

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[1] Pamela Paek, Eva Ponte, Irv Sigel, Henry Braun, and Donald E. Powers (2005), *A Portrait of Advanced Placement Teachers' Practices*. New York: The College Board.

[2] Chrys Dougherty, Lynn Mellor, and Shuling Jian (2006), *The Relationship Between Advanced Placement and College Graduation*, p. 14. Austin, TX: National Center for Educational Accountability.

• The number of African-American students receiving a passing score (3 or 4) on the State English I end-of-course assessment has risen by 7 percent.

• Average SAT scores have increased by 1.5 percent over the past 10 years, even as the number of students taking the SAT increased by 42 percent and the number of minority students taking the SAT increased by 88 percent.

In both the State of Florida and the Charlotte-Mecklenburg Public Schools, the data support the notion that a major commitment to AP expansion, especially when supported with other reform initiatives, raises overall student achievement, not just that of students who take AP courses.

Question 3. Finding highly qualified science and math teachers is often a problem for urban and rural schools. What can be done to retain teachers trained in Advanced Placement programs in difficult-to-staff schools?

Answer 3. Retaining teachers trained in AP in difficult-to-staff schools ultimately boils down to the issue of incentives. What incentives drive teacher decisions to remain at or to move from a school? What factors make a school a difficult-to-staff school? When teachers at urban or rural schools achieve a high level of competency in AP, they are noticed by other educators and are recruited with incentives such as greater salary, better teaching schedule (fewer preps and/or fewer periods), more stable class sizes in AP than would be the case in a rural setting, and a more stable learning environment than would be the case in an urban setting.

We have learned anecdotally that many AP teachers are more likely to persist in the profession because of the fact that they are AP teachers. That is, they find the challenges and rewards of AP teaching appealing, and many who would have otherwise left the profession remain teachers because of the opportunity to teach AP.

To retain high-quality teachers, the issue of incentives must be addressed. Incentives include the following:

• More competitive compensation, including salary and benefits;

• More planning periods;

• Fewer preparation periods;

• Opportunities to have mentors early in their careers—and to mentor other teachers later in their careers;

• Opportunities to collaborate with other teachers and with other faculty (e.g., college professors) on content-based projects, such as science labs and internships;

• Increased professional development opportunities—with compensation.

Question 4. Both national and international tests continually show that U.S. students do well through the 4th grade and then a decline begins. The decline becomes worse between grades 8 through 12. What are your recommendations as to how we can specifically improve grades 5 through 8 in regard to math and science instruction?

Answer 4. We agree that grades 5–8 are the critical grades most responsible for this decline. The majority of mathematics teachers at these grades, for example, hold an elementary (K–8) certificate and, thus, have far less than even a minor in undergraduate mathematics content. (The usual requirement for elementary majors at most colleges and universities is one general education math course plus one or two math methods courses related to teaching content exclusively focused on the mathematics taught in grades K–5 rather than grades 6–8.)

Our recommendation is that States explore some form of middle school certification in mathematics and science, with two possible requirements:

(1) Middle school teacher candidates have at least a minor in mathematics or science, and preferably a major in mathematics or science if they intend to teach in those fields.

(2) Middle school teacher candidates have methods coursework that is focused on training them in the skill of applying formative assessment strategies to diagnose what students know, and how they know it, and be able to apply this diagnosis to increasing student understanding, that is, in directing their mathematics or science content coursework to the task of teaching students.

We note that the College Board is conducting NSF-sponsored research on mathematics teacher professional development that is focused on three guiding principles of effective teaching in mathematics: (1) content—conceptual understanding is the key to deep and long-lasting content learning; (2) pedagogy—student thinking about mathematics is the key to getting students to learn mathematics; and (3) assessment—formative assessment strategies that discover what students know and how they know it are the keys to increasing student learning. We believe that these three guiding principles should be the basis of educating future teachers of mathematics and science.

AP can drive improved teaching and learning of science and mathematics in the middle grades. AP sets a standard for all students and teachers with its capstone learning standards. Through vertical teaming and other professional development experiences that bring middle grade and high school teachers together, and through district "back-mapping" of the curriculum that sets standards and required knowledge across grades 6–11 in a way that prepares students for AP success, AP can raise the bar and raise standards and expectations at all grade levels.

Question 5. The New England Association of Schools and Colleges has found that one of the primary reasons this Nation's students appear to do poorly after 4th grade in math and science on international tests is that the U.S. sets up math and science curriculum completely different than most other Nations. For example, in the U.S., calculus is usually taught in 12th grade and in other countries, it is taught in earlier grades. Thus, the international tests could be comparing apples to oranges. What are your thoughts on this?

Answer 5. Our initial reaction to the New England Association of Schools and Colleges' conclusion is that it is a red herring. If the problems on the international tests were explicit problems from calculus, then we could agree with the New England Association of Schools and Colleges' conclusion. However, looking at the TIMSS grade 8 items, we find these items to be seemingly consistent with the mathematics content that U.S. grade 8 students are being taught. The fact that the results are poor reflects that U.S. students are not learning this material very well. This relates more to the lack of preparation of middle school teachers in math content knowledge and their ability to help their students understand this content.

Is the implication here to move calculus down to earlier grades in the United States? We believe not. We have acknowledged the inability of U.S. schools to teach students middle school math and science content to a satisfactory degree. Moving calculus down would only make this problem worse, and it would raise new issues of what, then, should be taught in the higher grades to students who have taken calculus earlier, and whether teachers will be prepared to teach this new content well.

[Whereupon, at 12:15 p.m, the subcommittee was adjourned.]

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