S. HRG. 109–344

PROTECTING AMERICA'S COMPETITIVE EDGE ACT (S. 2198): FINDING, TRAINING, AND KEEPING TALENTED MATH AND SCIENCE TEACHERS

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 FINDING, TRAINING, AND KEEPING TALENTED MATH AND SCIENCE TEACHERS

FEBRUARY 28, 2006

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C O N T E N T S

STATEMENTS

TUESDAY, FEBRUARY 28, 2006

ADDITIONAL MATERIAL

PROTECTING AMERICA'S COMPETITIVE EDGE ACT (S. 2198): FINDING, TRAINING, AND KEEPING TALENTED MATH AND SCIENCE TEACHERS

TUESDAY, FEBRUARY 28, 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 10:00 a.m., in Room 430, Dirksen Senate Office Building, Hon. Lamar Alexander [chairman of the subcommittee] presiding.

Present: Senators Alexander, Isakson, Ensign, and Bingaman.

OPENING STATEMENT OF SENATOR ALEXANDER

Senator ALEXANDER. The hearing will come to order. This is a hearing of the Subcommittee on Education and Early Childhood Development of the Committee on Health, Education, Labor, and Pensions.

I am glad that Senator Isakson of Georgia is here, as well. Senator Dodd is the ranking Democratic member of the committee and he will be here; and others, I suspect, will be coming in and out on this busy day. But we want to thank the witnesses for being here. Senator Isakson has had a long interest in these issues. He was Chairman of the State Board of Education in Georgia and we are delighted that he is taking an active role.

This morning, we begin a series of two hearings on the education provisions of an act we call Protecting America's Competitive Edge, or PACE Act for short. The issue today really is brainpower. How does America keep its brainpower advantage, which is the way we keep our good jobs from going to China and India. It is the way we win the war on terror. It is the way we develop energy independence. It is the way we solve the health care crisis.

We are a very fortunate country. We have 5 to 6 percent of all the people in the world, and last year, we produced about 30 percent of all the money. A lot of things went into giving us that advantage, but none has been more important than our brainpower advantage; our educated workforce; our research; our great research universities; our community colleges; which help people go from one job to another and prepare for university. This is a subject that is on the minds of all of us.

Our Chairman of the full committee, Mike Enzi, has made this issue, competitiveness, his major interest and he has already held two very useful hearings on the subject of competitiveness. First, we heard from Secretary Spellings of Education. Then we heard from a panel of innovative leaders from around the country. He has asked us to take the ball in this subcommittee a little further down the road, which is what we hope to do today.

It is my hope that after we finish the hearings today and tomorrow, that the full committee will schedule a markup of the entire portion of the PACE Act that has been referred to this committee.

I will have a full statement that I will submit to the record, but first, I want to make sure that I summarize where this act came from and what its status is in Congress today.

Last May, Senator Jeff Bingaman, who is the ranking Democratic member of the Energy Committee and a member of this subcommittee, and I asked the National Academy of Sciences this question: what are the top 10 actions, in priority order, that Federal policymakers could take over the next decade to help the United States keep our advantage in science and technology? The National Academies of Science and Engineering and the Institute of Medicine invited 21 people, 20 of whom accepted, to answer the question. They were chaired by Norm Augustine, a member of the Academy of Engineering and the former Chair of Lockheed Martin. The group included three Nobel Laureates, university presidents, and a variety of people. In a very short period of time, they answered our question and they gave us 20 specific recommendations in a report, that has gained a great deal of notoriety in the country, that is called, "Rising Above the Gathering Storm."

Now, it is important to note that this isn't the first of such efforts. There already were Members of Congress, on both sides of the aisle, who for years have been focusing on this issue. There was another, at least one other important study, the Competitiveness Council, that Senator Ensign and Senator Lieberman have introduced legislation about. So we are all on the same train, really, headed in the same direction. We are not competing with one another. We are competing with the rest of the world.

We, Senators Domenici and Bingaman and Mikulski and I, took the 20 recommendations in the Augustine report and turned it into the PACE Act. In other words, out of respect for the work that was done, we introduced all 20.

The Energy Committee—those recommendations, the way the Senate works, have been spread around the Senate. The Energy Committee, under Senator Domenici's leadership, held a hearing earlier this month on eight of the provisions that were referred to their committee and they hope to report those to the Senate floor sometime during March.

Today, we are going to focus on five more of the provisions that have to do with teachers. Tomorrow, we are going to focus on four other provisions that have to do with students. There are in the full committee, full Health, Education, Labor, and Pensions Committee, another 19 proposals out of this group of 20. Some of them are subparts. Three are higher education, 16 have to do with research and immigration. Hopefully, after everything gets through the HELP Committee, it will go to the Commerce Committee for

30 days. The Finance Committee has three other recommendations from this, including making permanent the research and development tax credit. So you can see there is a lot to do.

So not only do we have a consensus document from the Academies, we have this PACE legislation, which now has 66, I believe, Senators—67 Senators as sponsors. That includes the Republican leader, Senator Frist, and the Democratic leader, Senator Reid, and the number of Republican and Democratic sponsors is nearly equally divided. So there is nothing else in the U.S. Senate today, and probably won't be this year, that commands such broad bipartisan support as the PACE legislation.

Now we get down to work, and we want to hear specifically about the UTeach program at the University of Texas. We want to hear specifically about a proposal for providing scholarships of up to $20,000 per year for undergraduate students to attend a program like UTeach. We want to hear about support for universities to establish a Master's degree program for current teachers who need to strengthen their skills, about providing a $10,000 fellowship to teachers that participate in either of the aforementioned programs who then go teach for 5 years, in other words, a pay supplement on top of their local teacher's salary. And we want to talk about summer academies for 50,000 teachers each year at our national laboratories and at universities.

Tomorrow, we will be talking about Advanced Placement courses and tripling the number of students who succeed in them, about establishing residential high schools for science and math of the kind North Carolina has had for 20 years, about providing an opportunity for middle and high school students to participate in education programs at national laboratories, and about a clearinghouse for math and science materials.

We have a distinguished panel today. We want to listen to you. We want to let you do most of the talking. We want to ask you some questions. We do it in two forms. The first witness, who I will introduce now, is Tom Luce from Texas, and then I will ask the other witnesses when we are finished with Mr. Luce if they will come up at that time.

Senator Isakson, do you have anything you want to say before I introduce Mr. Luce?

Senator ISAKSON. No. I am just delighted to welcome Dr. Luce. He and I met through Senator Sam Nunn about a year ago. We are delighted to have him at the Department and I am delighted to be with you today, Lamar.

Senator ALEXANDER. Thank you. Thank you, Johnny.

Tom Luce has a distinguished history in Texas, and Texas is doing some really amazing things in elementary and secondary education. Last week, I was with Uri Treisman, I guess, from Dr. Rankin's department and he was telling the group of educators what had happened in the last 15 years and that if Texas were a nation, which it considers itself one, I know that, but if it were a nation and it submitted itself to the international studies of science and math, Texas students, so I am told, who are more than half African-American and Hispanic, did better on math and science in the 8th grade international comparisons than the 8th graders in most European countries. So that was a significant finding, one I

hadn't heard before, and certainly is a great compliment to Mr. Luce and the group of business leaders who supported the last three or four governors of Texas in their standard efforts.

Mr. Luce, we are anxious to hear your comments on the PACE Act. We are anxious to hear your comments on the President's proposals. It helps to have the National Academies' consensus document. It helps to have the 67 Senators. It really helps to have the President of the United States put competitiveness on the agenda the way the President did in the State of the Union address. We look forward to your comments.

STATEMENT OF TOM LUCE, ASSISTANT SECRETARY, OFFICE OF PLANNING, EVALUATION, AND POLICY DEVELOPMENT, U.S. DEPARTMENT OF EDUCATION, WASHINGTON, DC

Mr. LUCE. Thank you so much, Mr. Chairman. I can't tell you what a pleasure it is to appear before you and Senator Isakson, in particular because of your long work in education and the State vineyards, so it is a real pleasure to be here today and it is very exciting to be here today, because as you say, to see 67 Senators signed onto a consensus report by the National Academy, to have the President make the comments he did in the State of the Union, and to have the Academy with their stamp of approval on significant recommendations is a real powerful moment for our Nation.

I want to thank you in particular for the amount of work you have personally put into this. It was the first time I had heard homework sessions were held here in the Senate, but you held homework sessions and I learned a lot from the homework sessions and I appreciate it very much.

What I am here to talk about today is not only the PACE legislation, but the President's American Competitiveness Initiative, and what we want to start off by saying is we are in total agreement with the Academy when they say the number one priority is to improve the K through 12 math and science pipeline of our Nation immediately. That is important not only for the next generation of Nobel Prize winners and our innovators, but also for every student who wants to successfully compete in the information age of the 21st century. An educated workforce in the information age is going to require more knowledge of math and science than I had when I graduated from high school.

To address these needs, the President in the Competitiveness Initiative put forward a comprehensive program for the K through 12. It starts with a National Math Panel, which the Secretary plans to convene shortly, that would begin to help us inform better instruction of the K through 12 math system in our country. And then if Congress agrees to support this initiative, we would have $125 million to put behind better math and science instruction in K through 6. We also have a similar program for middle school that is also under the Math Now Initiative that would be, again, based upon the National Math Panel's findings of what are the right kind of interventions to bring our students up to grade level. And all of this will start within the month, we hope, with the National Math Panel.

Another key initiative is in the high school level, where we support entirely the recommendation of the Academy with regard to

enhancing the Advanced Placement program through incentives. We believe it is realistic to triple the number of students taking and passing Advanced Placement math and science courses. I have recently looked at data of the College Board and they tell us that there are 500,000 students in our country today who took the PSAT that, based upon that PSAT test, could take and pass Advanced Placement calculus today that are not enrolled in those courses. That is low-hanging fruit that we need to take advantage of through this Advanced Placement program.

We also are going to move swiftly—Congress passed the Academic Competitiveness Council in its Deficit Reduction Act. We are going to move swiftly to convene that council to look at the $2.8 billion of math and science programs that exist today across the Government in all civilian agencies plus the Department of Defense, to coordinate those programs, to prioritize them, and to make sure that we are following the guidelines and principles of No Child Left Behind.

So let me just conclude so I can address your questions that we feel very strongly that the right emphasis was placed on the K through 12 pipeline. I think that is an important statement by the Academy, which recognizes the importance of producing that and increasing that pipeline so that everybody in our country can enjoy that standard of living that we have enjoyed in the 20th century and in the 21st century.

We look forward to working with the Senate and the House to find the right combination of measures. We think it is wonderful that so many people have put on the table various math and science proposals and we look forward to working with you to find that right combination. We believe that we have made a good start with the President's initiative, which will—I want to emphasize in closing, what we are trying to do is take programs to national scale. We believe that we have had a sufficient amount of pilot programs, demonstration programs, and what we are looking to do is take something to scale so that we can immediately increase that pipeline so that we can remain as competitive as we are today.

Thank you, Senator Alexander.

[The prepared statement of Mr. Luce follows:]

PREPARED STATEMENT OF TOM LUCE

Good morning. Thank you for inviting me here today. I want to begin by thanking Chairman Alexander and the members of the subcommittee for your leadership in recognizing the growing challenge to American competitiveness in the global economy of the 21st century, and for your efforts to drive home the importance of this issue for both Congress and the American people.

If you think back over the past century, the world has made truly astounding progress in science, technology, engineering, and mathematics. And in virtually every field—from medicine, communications, transportation, agriculture, energy, and computers—American innovation has led the way. More than any country on earth, our economic system rewards the ambition, imagination, and hard work that generate new ideas and new inventions.

But another key to innovation is education, and I don't think it's a coincidence that the world leader in technology, with just 6 percent of the world's population, continues to graduate more than ⅕ of the world's doctorates in science and engineering. Or that 38 of the world's 50 leading research institutions are in the United States.

AS WORLD CATCHES UP, U.S. RISKS FALLING BEHIND

At the same time, there is no doubt that the world is catching up. The spread of political freedom across the globe with the end of the Cold War, combined with the communications revolution brought by the Internet, have quickened the pace of innovation and dramatically increased global economic competition. As Commerce Secretary Carlos Gutierrez has said to me, "We've won the Cold War. Capitalism prevailed, and we have 3 billion more competitors. Now we just need to run faster!"

Increased global competition benefits both the United States and the world. But it does present new challenges. Evidence of these new challenges is not hard to find. In 2005, a majority of the top 10 recipients of patents from the U.S. Patent and Trademark Office were foreign-owned companies. Over the past 15 years we have gone from a leading exporter of high-tech products to a net importer of those products. In addition, America's share of the world's science and engineering doctorates is expected to fall to 15 percent by 2010.

Moving further down the educational pipeline into our elementary and secondary schools, the United States also appears to be losing ground. Even though the 1983 *Nation At Risk* report recommended a minimum of 3 years of math and 3 years of science for all high school students, today just 22 States and the District of Columbia require at least this much math and science to graduate from high school. And there are plenty of data suggesting that we are paying a high price for this delay in putting a stronger emphasis on math and science in our schools.

Nearly half of our 17-year-olds do not score at the Basic level on the National Assessment of Educational Progress—the minimum level of math skills required to apply for a production associate's job at a modern automobile plant. American 15-year-olds ranked 24th out of 29 developed nations in mathematics literacy and problem-solving on the most recent Program for International Student Assessment test. And just 7 percent of America's 4th and 8th graders reached the Advanced level on the 2003 Trends in International Math and Science Study (TIMSS). By comparison, 38 percent of Singapore's 4th graders and 44 percent of its 8th graders scored at the Advanced level on TIMSS. Our students are not just failing to keep up with their international peers; they also are not getting the preparation they need to succeed in the workforce or in our colleges and universities. Less than half of our high school graduates are ready for college-level math and science.

These data make a strong case that if we want to maintain our competitive edge in the global economy, we need to take action now. As the U.S. Chamber of Commerce recently noted, in its State of American Business report describing the challenge of remaining competitive in a global economy, "These are not academic questions for think tank futurists in ivory towers. They are "here and now" questions that demand serious attention this year."

AMERICAN COMPETITIVENESS INITIATIVE

I believe the Chamber, the Business Roundtable, the National Association of Manufacturers, and others in the business community have got it exactly right. We need to improve math and science education right now, this year, so that in the future, all students have the skills they need to be successful in higher education and the workplace. And we need to ensure that all students have the skills they need to enter the pipeline of future scientists, engineers, and mathematicians. This is why President Bush has proposed his American Competitiveness Initiative (ACI), which includes $380 million in new funding to improve the quality of math and science education in our elementary and secondary schools, bringing the total the Department spends on math-science to almost $1 billion.

The ACI would fund several activities designed to strengthen math and science education from kindergarten through grade 12. The Math Now for Elementary School Students initiative would provide $125 million in competitive awards to implement proven practices in math instruction that focus on preparing students in elementary school for more rigorous courses in middle and high school. In particular, our proposal emphasizes the importance of teaching and learning algebraic concepts in elementary school, so that students have the foundation they need to take and pass algebra. Algebra is a true "gateway" course for students going into postsecondary education, and ultimately the workforce, as demonstrated by Department data showing that 83 percent of students who took algebra and geometry went to college within 2 years of high school graduation, while only 36 percent of students who did not take these critical math courses enrolled in postsecondary education.

A companion proposal, Math Now for Middle School Students, would focus $125 million on identifying and implementing research-based interventions for middle school students who have fallen behind in mathematics. This competitive grant initiative is similar to the Striving Readers program, and reflects the President's deter-

mination that struggling students receive the extra help they need to succeed in math.

Both Math Now proposals would be informed by the work of the National Math Panel, which Secretary Spellings will move quickly to create this year. The Panel will work to identify the essential principles, practices, and components of effective mathematics instruction, and its recommendations will be a key consideration in making awards under the Math Now proposals. In addition, our 2007 request includes $10 million to help disseminate the Panel's findings and put its recommendations to work in K–12 classrooms nationwide.

ADVANCED PLACEMENT

At the high school level, the key ACI proposal—and one that is shared by the PACE-Education Act—is $90 million in new funding to expand teacher training under the Advanced Placement Incentive program, with an emphasis on AP instruction in math, science, and critical foreign languages. In combination with State and private matching funds, the proposal would train 70,000 teachers over the next 5 years to teach math, science, and critical foreign languages in AP and International Baccalaureate (IB) programs. New awards would be targeted to schools with high concentrations of low-income students that otherwise typically do not offer AP or IB courses, helping these schools to train the next generation for the global economy of the 21st century.

The potential impact of expanded AP and IB offerings is demonstrated by a College Board study of students whose scores on the Preliminary SAT (PSAT) suggest they have the potential of earning a 3, 4, or 5, which is generally considered a "passing score," on an AP exam if they had the opportunity to take one. These data suggest that the number of students in Tennessee who would be likely to pass AP tests in subjects like Calculus, Chemistry, Physics, and Biology is 5 to 10 times greater than the number of students currently achieving passing grades in these subjects. This is why, for example, the College Board estimates that in 2004 there were nearly 500,000 high school students whose PSAT scores indicated that they were ready for AP Calculus but who did not take the course for whatever reason.

This is strong evidence that the President's AP proposal could help significantly increase the number and percentage of high school graduates who not only are prepared for college-level math and science, but also have already passed college-level exams in high school. Our long-term goal is to increase the number of students taking AP-IB exams in math, science, and critical foreign languages from 380,000 today to 1.5 million in 2012, and to triple the number of students passing these tests to 700,000 by 2012.

Another ACI proposal that would help strengthen math and science education in our high schools is the request for $25 million to create an Adjunct Teacher Corps. This initiative would encourage experienced professionals with subject-matter expertise, particularly in math and science, to teach in secondary schools through such arrangements as part-time instruction, teaching while on leave from their regular jobs, or providing instruction online. There is no question that there is tremendous demand from schools for the kind of expertise that could be made immediately available through the Adjunct Teacher Corps. Department data show, for example, that nearly two-thirds of all school districts report that recruiting qualified science teachers is a significant challenge, and over 90 percent of districts with high percentages of minority students reported difficulty in attracting highly qualified applicants in math and science.

NEED TO SPEND BETTER, NOT MORE

I know there has been some concern expressed that we need to invest more in improving math and science education, and in filling the pipeline of teachers and researchers in science, technology, engineering, and mathematics. I also know that the PACE-Education Act proposes a wide range of new programs designed for this purpose.

As you heard from Secretary Spellings, we believe that the combination of existing programs and the new resources provided by the American Competitiveness Initiative are sufficient to meet our national needs. The resources are there.

That's not to say, however, that we couldn't spend those resources better. According to a GAO report, 13 different government agencies are spending about $2.8 billion on 207 different programs for math and science education, so we should look closely at the effectiveness of all of the critical investments for this purpose.

This is why the President is proposing $5 million for an Evaluation of Mathematics and Science Programs that would build on the work of the Academic Competitiveness Council already created by the Deficit Reduction Act of 2005. The addi-

tional funding is needed to bring a more rigorous approach to assessing Federal elementary and secondary math and science programs, and, when appropriate, to permit examination of the extent to which these programs reflect the core accountability principles of No Child Left Behind (NCLB).

NCLB SUPPORTS IMPROVED MATH AND SCIENCE INSTRUCTION

It is important to recognize that our No Child Left Behind (NCLB) reforms have already been working to improve both teacher quality and instruction in math and science. For example, the implementation of reading and math assessments, beginning this year, for all students in grades 3–8 will for the first time ensure that parents, teachers, and principals know how well our schools and students are performing in math each year. And in 2 years, States will put in place science assessments as well.

We also are making considerable progress under NCLB in addressing the issue of teacher quality. The law requires all teachers in core subjects to be highly qualified by the end of the current school year and, while we know that not every State and district will hit that mark this spring, we believe the vast majority will be very close, and we are working with them to ensure that they will reach this goal as soon as possible.

In addition, States are moving to ensure that, in accordance with NCLB, minority and low-income students are not taught by inexperienced, unqualified, or out-of-field teachers at higher rates than other children. This is absolutely critical for improving instruction in fields like math and science, which often are taught by out-of-field teachers in urban and rural areas alike. For example, an analysis by the Education Trust-West found that 44 percent of math classes in California's high-poverty high schools are taught by teachers without a certification in that field. The story is even worse in California's high-poverty middle-schools, where more than 90 percent of math classes are taught by a teacher without a major or minor in mathematics.

The President's 2007 budget includes $2.9 billion to help States meet NCLB teacher quality requirements, and school districts also are required to use 5 percent of their title I allocations, or about $624 million in fiscal year 2007, for professional development intended to ensure that all teachers are highly qualified. In addition, the Teacher Incentive Fund, funded for the first time in 2006, will encourage States and districts to provide financial incentives to teachers who help improve achievement in our highest-poverty schools.

Congress also recently acted in approving the Deficit Reduction Act of 2005 to provide critical incentives for postsecondary students to study math and science, and for qualified graduates to teach those subjects in our public schools. For example, this fall the new SMART Grants program will begin providing additional financial support to college students majoring in science, technology, engineering, and mathematics. And Congress made permanent a provision providing up to $17,500 in loan forgiveness for highly qualified math and science teachers serving low-income communities.

CONCLUSION

In conclusion, while we are making good progress through the broad tools of No Child Left Behind, it is clear that we need to jumpstart improvement in math and science education through the American Competitiveness Initiative, just as the President's Reading First initiative 4 years ago helped spur more rigorous reading instruction. The ACI represents a comprehensive, measured approach to improving math and science education in our public schools and building a competitive workforce for our 21st century economy. It would draw on proven instructional methods to prepare elementary school students for more rigorous courses in middle and high school, help students who have fallen behind in middle school to catch up, raise expectations for high school students to take and pass challenging AP and IB courses, and streamline Federal math and science education programs and align them with NCLB accountability principles.

Finally, let me again express my appreciation for the leadership provided by the Chairman and other members of the subcommittee on the critical issue of improving math and science education. The members of this subcommittee obviously "get it" when it comes to the importance of math and science to our future competitiveness and prosperity, and I hope that your efforts will help change our culture so that all Americans, and especially our young people, "get it" as well.

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

Senator ALEXANDER. Thank you very much, Mr. Luce.

Mr. Luce, I am very pleased with the President's proposals and I am especially pleased of where he places this on his agenda, because I know very well that the President, not the Senate, is the Nation's agenda setter. So when you and the President speak as he is doing of this, this helps us with our job. We will look carefully at the proposals he has made and that you have made about K through 12. I agree that the Advanced Placement discussions, which we will be having more of tomorrow with representatives of the Department, and Gaston Caperton, and Peter O'Donnell, I think, is coming tomorrow from Dallas, so that program was pioneered in Texas. You know about it? We can talk about that tomorrow.

But there are four or five provisions that were in the PACE report that are not in the President's recommendations. I don't expect you—having been in your shoes before, I know we all work within a budget and we all support the budget if we are in the administration, but I think it is at least fair to ask you, because you have some particular knowledge of some of these programs, about the value of the programs, not whether the administration is ready to fund them or support them.

For example, the UTeach program at the University of Texas, are you familiar with that program and what is your opinion of it?

Mr. LUCE. I am. I have spent a great deal of time with Dean Rankin myself. I have met with some of the students myself. It is a superb program. We simply, in the business, as you said, of setting priorities, we felt it was important to embrace totally the Advanced Placement program, not just because of the test taking of students, but to immediately help to train existing teachers, 70,000 teachers, to give them more professional development.

As you know, we lack a great deal in terms of content knowledge of our existing teacher corps. The UTeach program, of course, is working on our future teacher corps. We felt we had to address immediately to upgrade the content knowledge of our 235,000, approximately, K through 12 math and science teachers, and that doesn't count elementary school teachers. So we just simply chose to let us focus first on the existing teacher corps. But the UTeach program is a wonderful program.

Senator ALEXANDER. Is it possible that in your review, I think you said the number is $2.8 billion of funding that now exists for math and science throughout the Federal Government?

Mr. LUCE. And that doesn't count the Defense Department.

Senator ALEXANDER. So is it possible that in your review of that, that we might find that the UTeach program was a superior program to some existing program and that that might free up funds which might be available for it?

Mr. LUCE. We hope that that prioritization will start as soon as the council is convened. What we plan to do first is to make sure that existing programs are really aligned behind No Child Left Behind. For instance, what we have found already is that most of those programs do not have an assessment mechanism in them, nor are they addressed to the needs of teachers who have not reached highly qualified teacher status, nor are they directed toward schools that are not making adequate yearly progress.

So what we want to do is make sure that those immediate changes can be made, then start to evaluate the effectiveness of each program. That is the reason why we asked for funding for that process of $5 million, so we could do more ongoing evaluation to try to make sure, do we need to shift how some of that money, not only how it is being spent in accordance with No Child Left Behind, but maybe to emphasize new programs.

Senator ALEXANDER. One of the recommendations in the PACE report gets at the persistent problem of a lack of what we call differential pay, paying outstanding teachers more, teachers with a special need more. The proposal is to take graduates such as those who might come from the UTeach program or current teachers who earn a Master's degree and give them a National Science Foundation fellowship of $10,000 a year for 5 years if they agree to teach math and science in an inner-city school. Does that sound like a worthy idea to you, something that might end up on a priority list 1 day?

Mr. LUCE. Clearly, Senator, I think we all have to address the issue of differentiated pay for math and science teachers. We know there is a shortage and there will be a shortage, and that is the reason why we were so supportive of Congress creating the Teacher Incentive Fund, so that we can help incentivize programs that reward teachers in different areas, reward teachers for additional duties and responsibilities, and incentivize them to move to our higher-need schools, and we will be using the Teacher Incentive Funds, for instance, as a way of doing that.

In addition, as you know, in the Advanced Placement program, there is a great deal of incentives. So we hope to start the concept of incentives and demonstrate that incentives can work and can be appreciated by all teachers for the additional service and work and good quality work that they do. I always said in Texas, a great teacher deserves a great salary.

Senator ALEXANDER. Thank you.

Senator Isakson.

Senator ISAKSON. Thank you, Senator Alexander. I appreciate very much your reference to No Child Left Behind. I really am very proud of President Bush for having stuck to his guns to see it through, its passage, and then stuck to his guns, and Dr. Margaret Spelling has done a great job, because I think one of the key things we can do for math and science improvement in terms of our students in the 21st century is building the foundation.

Am I not correct that the assessments now for 2 successive years are showing conclusive evidence in inner-city minority poor and rural poor, improvement in terms of mathematics?

Mr. LUCE. Absolutely, as did the recent MAPE test. As these two Senators certainly know, we closed more gaps in terms of the achievement gap in the last 5 years than in the previous 30 years, and those gaps are closing. I would point out, Senator, particularly in Georgia, there was a 14 percent gain in math achievement for African-American students just from 2002 to 2005, and there was an 11 percent gain among Hispanic teachers. I would also point out, of course, that you all in Georgia can require—I can say you all, I guess, to you——

Senator ISAKSON. It is in our dictionary, yes.

Mr. LUCE. It requires 3 years of math and 3 years of science. Unfortunately, we only have 22 States that do that.

Senator ISAKSON. We moved, in the college prep diplomas in high school now, we have moved to 4 years of math required for acceptance into the university system.

But my reason for mentioning that is it is going to take the sustained commitment on qualified teachers to accomplish the goals Lamar is trying to accomplish and all of us are trying to accomplish.

Second, and this is a little bit offbeat, but I mentioned this to Senator Alexander and I want to mention it to you, and I have actually furthered my development of this idea, Lamar, since I talked to you about it. In reality, and I will use my State as an example, the difficulty in Advanced Placement instruction accessibility to students is not just the number of teachers, but it is also the number of teachers who are willing to live and reside in many places in the United States because they are rural, because they are long distances and those types of things. I think we are fooling ourselves dramatically if we think those 70,000 math and science teachers are going to go to work in some remote, yet beautiful areas of our country.

But to that end, there is a demonstrated program in the United States military today called e-Army U., which Senator Bob Kerrey and I worked on a number of years ago, which is successfully delivering high-quality content to the sands of Iraq, to countries in inner-continental Africa, and around the world. We have got people graduating now from college over the Internet in our armed services. Might not we need to take a look at the Department being the source or a conduit for us to investigate the delivery of high-quality Advanced Placement content via the Internet to many of the areas, inner-city and rural in this country, where you are just not going to get the number of teachers you need to accomplish your goal?

Mr. LUCE. Well, I certainly totally agree with you in terms of the objective, and it remains for Congress, I guess, to decide whether the Department of Education should do that or the College Board people should do that. But I totally agree that the advances in videoconferencing today and the Internet, those tools really can enable us to take a top-quality course to every school in the country, and that is what is desperately needed. We have too many schools that do not offer Advanced Placement courses and those are particularly in urban, poor areas and in our rural areas. The Advanced Placement incentive program we have requested and I believe that the Academy calls for, as well, calls for that being done via the Internet and allows funds from the incentive program to go to developing and sending those programs to all those schools you mentioned.

Senator ISAKSON. And I believe, in fact, I am sure I am right, the cost now to equip a classroom and have accessibility and interactive accessibility for students is less than the cost of an Advanced Placement teacher.

Mr. LUCE. I think that is absolutely correct, and I think we can also enhance the ability of teachers to deliver quality demonstrations, models, laboratories, etc., and I think there is a lot that can and should be done in that area. Our competitors, for instance,

APEC, the Asian countries, have formed a Web site among themselves of math and science practices. There is also one that Tom Friedman constantly cites that was put out by China called, I think it is called Haymath, that does the same thing. We need to remain competitive with the rest of the world.

Senator ISAKSON. Thank you, Mr. Chairman.

Senator ALEXANDER. Mr. Luce, following up on Senator Isakson's interest, I want to talk about programs for current teachers. In the PACE recommendations, there is a provision to provide grants to colleges and universities to partner with teacher preparation programs to develop Master's degree programs in math and science for current teachers, and there is a program to use national laboratories as well as colleges for summer training programs for teachers. For example, I know in Tennessee, we have had good success with Governor's schools for students and for teachers for 3 or 4 weeks.

I add those two provisions to comments I heard last week at an Aspen Institute discussion of education by one of Dean Rankin's scholars, Uri Treisman, who is the Executive Director of the Charles A. Dana Center for Mathematics at the University of Texas at Austin. He was extremely complimentary of the work of the University of Phoenix in teacher preparation. He said they took it very seriously. They did it online. I, for one, go into that with some skepticism, wondering whether it will work, but I was very impressed with his comments.

So I am wondering, as the Department thinks about current teachers and how to upgrade their skills as quickly as possible. We have proposals here in our joint proposals for Advanced Placement training. That would be one way . There are, also, two PACE proposals for Master's degrees and then one for summer academies at energy laboratories and at universities. And then I think Senator Isakson is saying to us, let us take advantage of very good online programs. Maybe if you have a series of summer institutes, it doesn't stop just with an institute, but there is continuing education and the online program comes in, in that way. Talk for a moment about how you look at online programs as a part of teacher training.

Mr. LUCE. Well, I personally have not—I don't have any personal knowledge of the University of Phoenix program, but I do know that, as you mentioned earlier, the UTeach program, of course, has been very successful in making sure that the students got the math and science content, but also received the training from the School of Education, but they received that in the Colleges of Natural Sciences, which I think is a wonderful model.

I would say also that we would hope that we would get proposals into our grant program, such as the math and science partnerships, where States would say to us, we want to enhance professional development online. Not only are we going to ask the other civilian agencies and the Defense Department to relook at all the programs they are doing now in math and science education, and there are something like 209 programs in these other agencies, but we are going to do that same rigorous look ourselves, and one of the things we have to address as a top priority is lack of math and science content knowledge of our teachers. I think that is true not only in

high school, as we discussed, but it is certainly true in our elementary schools.

Deputy Simon from the Department of Education recounts when he was Commissioner in Arkansas, Arkansas University that year graduated 6,000 elementary school teacher candidates and one physics major, and he said, unfortunately, that physics major moved out of State. So we have a content need that has to be met and online—we would hope States would come to us with proposals to enhance professional development in all sorts of ways.

Senator ALEXANDER. Let me ask you one more question and then I will go back to Senator Isakson and then we will move to the next panel. This work you are doing to look at the current programs in math and science, there is a lot of interest in that on this committee and there is a lot of interest in the House of Representatives about duplicating math and science programs before we start any more. At the same time, some of us are trying to move this PACE package and the President's proposals along and get them done in the next few weeks with the hope of passing them this year.

Are these two trains going to pass in the dark or will your study of duplication be far enough along so that we could sit down with the administration and say, okay, we are now at the point that we need to make some decisions. Can you give us some advice about existing programs so they might be modified or eliminated or improved, whatever they ought to be, so that we might be able to include in our final result funds for other programs we think are higher priorities, such as the PACE recommendations?

Mr. LUCE. Well, I would say, in your opening remarks, you laid out, from our perspective, a wonderfully aggressive schedule to move this math and science legislation forward, and frankly, I don't know if we will be able to move as quickly as you are moving, but I can assure you that we will be in constant communication with you and with House members interested in the same subject, because the President himself is very, very interested in making sure that this is done and we hope to launch that effort in the next several weeks. So we will be moving as swiftly as possible, but I can't speak for other cabinet members as to how quickly they will be able to respond to our request. But I know they are going to get the support to do that from the President and from OMB.

Senator ALEXANDER. Thank you very much.

We are glad to be joined by Senator Ensign, who is the principal sponsor of a major piece of competitiveness legislation of which I am glad to be a cosponsor. Senator Ensign, we are going to Senator Isakson for questions, then we will go to you, and then we will go to the next panel.

Senator ISAKSON. Not to wear out the horse I started riding in the previous question, but when you and Lamar were talking about the highly qualified teacher, one of the other real aspects to this distance learning component or using technology is that a teacher in mathematics or science monitoring a class taught via the Internet by an Advanced Placement expert can, in fact, improve their content knowledge as they monitor and teach those classes. So you have a two-fold—it is kind of a double-whammy, so to speak. First of all, you are delivering what you know is highly qualified content via the Internet, and second, you have a teacher who might not be

highly qualified, but with that exposure can be, and I just will close by one example.

Glee Smith of my staff, if she is still with me here, I will tell you a little story to illustrate the power of that. We went to Menia, Egypt, in 2002 tracking U.S. foreign aid education money through NGOs to the most rural, impoverished areas on the globe. We went there and went to Ethiopia. We went to a village in Egypt, Menia, where they were teaching Egyptian children, young girls who, by the way, had been denied to go to school up until just a couple of years before, English and they were teaching them the following mechanism. They supplied them with a boom box that had an eight-track audio tape that played "One little, two little, three little fingers," instead of "One little, two little, three little Indians," and they would teach them to sing that song to teach them to count, one, two, three, four, five.

What was interesting was the teacher that was monitoring these children didn't speak English, either, and she was learning English via the exposure of those audiotapes the same way you would by downloading high-quality content via the Internet. In fact, today, over in Northern Africa now, they have a stationary satellite where they can beam that down over broadband. So it has a powerful assistance, not only to deliver high-quality content to children, but also to deliver exposure of that content to an otherwise qualified teacher to enhance their ability, and I will get off the technology stuff now and yield to my distinguished colleague from Nevada.

Mr. LUCE. If I might respond briefly——

Senator ISAKSON. Absolutely.

Mr. LUCE. [Continuing]. Attempt to ride side-saddle on your horse, I would also point out that the President in his initiative has called for the use of an adjunct teacher corps, where we hope to bring in from the private sector people who could help existing teachers and teach themselves, and I think the importance of that is they can bring into the classroom for teachers to observe and see relevance from the current workplace, which I think is needed to encourage our students to really understand the power of math and science.

Unfortunately, oftentimes when we talk about math and science, somebody immediately thinks, well, my son or daughter is not going to be a mathematician or a scientist, but we need to bring alive what is done by people using that foundation of education, the exciting many things that they can do in the workplace or in medicine or many other vocations. They may not be, quote, "labeled" a mathematician or a scientist, but if they didn't have that foundation, they wouldn't have that job.

Senator ALEXANDER. Senator Ensign.

Senator ENSIGN. Thank you, Mr. Chairman, and thanks for putting this hearing together and for your leadership on the issues of education, competitiveness, and the direction that our country needs to go. I think a lot of us have finally woken up to where we are as a country and where we need to go. We understand the type of world we live in today, where students from my State aren't just competing with students from Tennessee, but they are competing with students from all over the world in the global economy. Obviously, the focus today and tomorrow is on some of the competitive-

ness issues in education. What can we do to make us more competitive in the world really is the question we are faced with.

I had a great breakfast with Secretary Spellings 2 weeks ago, and we talked about some of these issues. What I want to focus on, Mr. Luce, is when we are looking at—and we touched on this briefly in the breakfast—how childen learned to read in the United States. We realized that children weren't learning to read, so we identified some of the problems, at the Federal Government level. When things are going awry, the Federal Government has the resources to do the research that is necessary to identify problems and solutions.

We found that we were teaching reading, but needed to get back to the basics of phonics. In looking back at the reading wars and some problems that led to some of the lack of reading skills, I guess that we are starting to see the same issues in math. Maybe you want to comment on some of that, where do you think we are going with improving how we teach math. I took about every kind of math class that there was when I was growing up and I ended up going into the sciences and veterinary medicine. Math and science were important to me. But kids today are more advanced as far as the amount of math that they have to take, and yet they seem to be learning a lot less of it. So that is, I guess, the quandary that we have today.

Can you maybe comment on how the research is going and where we need to go from here to help schools and teachers identify why students are taking all this math but are not learning as much?

Mr. LUCE. I am sure the Secretary discussed with you in her breakfast her desire to launch this National Math Panel that we hope would do exactly what you are saying, and seeing it as possible. I have been looking at this problem since I came to the Department last July and it seems to me that the National Math Panel can not only do what the National Reading Panel did, which was to sift through the scientifically-based evidence that does exist, but can also identify some principles and practices and components for which we have evidence-based outcome results which we could share with States, all of this on a voluntary basis.

But I think we have an obligation to step forward and say, look, here is what the scientifically-based evidence shows and also here is what some promising areas look like, and also have that panel identify for the Institute of Education Sciences what are the particular areas that we need to emphasize in our research.

I have already heard over and over, I met with a lot of distinguished mathematicians over the last 6 months and I hear constantly that we need to instill in our youngers in K through 6 more and more of what I would call in my langauge terms pre-algebraic concepts so that when our students reach middle school, they can take and pass algebra I and II, which then sets up their ability to really take the math and science courses which we all need. Not enough of our students are prepared to do that today.

I would say the American High School Diploma Project, which both Tennessee and Georgia, I know, are members of, is stressing that algebra component and it certainly is a critical need. I think, though, that we have got to communicate to the public. Our Secretary is fond of saying that when then-Governor Bush first talked

about reading in elementary school at the end of the 3rd grade, every head would nod. But if you stood up and said, we want every student to take and pass algebra in 8th grade, heads might move like this. We have a teachable moment here, as she would say, in terms of this momentum on cover stories and everywhere else to really explain to the public, and I think that is the value of hearings, that we need this——

Senator ENSIGN. Secretary Luce, along those lines, I don't know if the math panel is going to be looking at this, but part of increasing reading skills was motivating children to learn to love to read and looking at some of the reasons that children chose to read. For instance, why do boys not like to read as much as girls? Part of the answer, from what I understand, is how important it is for fathers to read with their sons and so that young boys had a good model to follow.

A couple of years ago at the National Prayer Breakfast, Mr. Chairman, Dr. Ben Carson was the keynote speaker. Dr. Carson grew up in the inner city of Detroit, was raised by a single mom, and was one of the worst kids at his school. He ended up becoming motivated and obviously one of the great neurosurgeons of the world today and is now a great pediatric neurosurgeon from Johns Hopkins University. But he talked about how we are motivated and what we need to do to motivate some of our kids. One of the things he talked about was as long as we hold up athletes and musicians as role models, and don't put the innovators of the world on a Wheaties box and hold them up as role models, it is going to be difficult to encourage children to take STEM courses.

So I hope that this math panel will also be looking at some of those issues, as well, not only the teaching techniques, but also how we should motivate the next generation of Americans. We used to have the space program that motivated a lot of people to go into engineering. Well, we don't have something like that for children to aim for today. Our kids are exposed to more things in their fantasy worlds of their video games than anything in the real world. How do we motivate that next generation?

Mr. LUCE. I certainly agree. There is an employer in Senator Alexander's State that is in the computer business that supplies parts to students in high school to build their own computer and their own MP-3 players as a way of demonstrating what you can do with math and science skills. I think if we can—I am also familiar with a program in Texas where Texas Instruments helped develop, with Southern Methodist University, an actual engineering curriculum for high school so that—and it was approved by the State of Texas, so that students could actually take, quote, "engineering" and learn some applications and some exciting things that they could do with math and science knowledge. I think the 50 Governors in their National Education Summit a year ago said relevance and rigor were the two most important things that had to be brought to high school.

Senator ALEXANDER. Thank you, Secretary Luce, for your time. We want to welcome Mrs. Luce, who joined you today. I want to personally thank you for your years of work in Texas and this country with the passion to improve education.

Mr. LUCE. Thank you, Senator, and thanks to each Senator here. Thank you.

Senator ALEXANDER. I would like to invite the next panel of witnesses to come up and we will get started. In fact, as you come up, I will begin introducing you and that will save us some time so we can get on to this.

I would like to say that Senator Dodd, who is the ranking Democratic member of the committee, is one of the most enthusiastic and active cosponsors of this legislation and he wanted me to say to the witnesses that he is at a Rules Committee meeting, a markup, and he regrets that it conflicts with this. He hopes to be here shortly. Since I suspect this is the Rules Committee markup on Congressional ethics, my guess is he would much rather be here than there, but he is there. He wanted me to be sure and say that.

I also want to insert into the record a statement from the Chairman of the full committee, Senator Enzi, who was also unable to be here this morning. In addition, I wish to include a statement from Senator Kennedy.

[The prepared statement of Chairman Enzi follows:]

PREPARED STATEMENT OF SENATOR ENZI

Thank you, Mr. Chairman, for holding this subcommittee hearing and providing us with the opportunity to learn from those who are working to ensure that our students are the best in the world and that they continue to receive an education that is second to none.

We live in an age in which knowledge is king and a good education is the golden key that our children will use to unlock their full potential. That potential will someday be reflected in a career that is both rewarding and satisfying.

That is why, if we are to remain competitive in today's global economy, we must find ways to encourage students to stay in school and prepare for and enter fields that demand a high level of skills like careers in math, science, engineering, health, technology and critical foreign languages. In order to do that, we need a highly qualified teacher in every classroom who expects great things from every student they teach.

In today's hearing, we are focusing on math and science teachers. To be well-prepared, these teachers must have an in-depth knowledge and understanding of math and science and possess the kind of teaching skills that help to make students excited about learning.

How can we attract more math and science majors to teach in our middle schools and high schools? How can we ensure that current math and science teachers who are highly qualified are supported and remain in the classroom? How can we provide every child with the kind of classroom experience that assures them that they can be anything they want to be if they are willing to work hard—and study even harder!

The answers to these questions won't be easy and, unfortunately, just when we recognize the need for more skilled teachers, we are experiencing a significant aging of our teacher workforce. Over the past 2 decades, the median age of primary and secondary school teachers has increased from 36 to 43. In 2000, teachers age 40 and

over accounted for 60 percent of the teacher population, compared with 40 percent in 1980.

With a large number of teachers approaching retirement age, we have a dual dilemma: attracting the 2 million new teachers that will need to be hired in the next decade and making sure they have the talents and skills they will need to make a difference in classrooms all across the country.

Good pre-service preparation is critical. But in-service professional development experiences are also essential if we are to keep highly qualified teachers in the classroom. Research shows that providing extra support through induction programs to teachers in their first 3 years of teaching increases both their success as teachers and their retention in our teacher workforce. Especially in education, school is never out and learning never ends.

Earlier this month, we heard from Secretary of Education Margaret Spellings on the role of education in meeting the challenges of global competitiveness. Roundtable participants talked to us about building and filling the pipeline so more high school students graduate on time prepared for both postsecondary education and the workplace, and not in need of further remediation.

We look forward to hearing today from people with a variety of perspectives who can contribute to our understanding of how to improve teacher education programs at the undergraduate level, and providing more, high quality opportunities for continuing education professional development. I want them to know how much we all appreciate their attendance and their participation.

Using the information we have obtained previously and what we will learn from today's hearing, we can pursue a legislative approach to address the important concepts laid out in the PACE bills. Working together, I have every confidence we can meet the challenges before us.

PREPARED STATEMENT OF SENATOR KENNEDY

Thank you, Senator Alexander, for scheduling today's hearing on math and science teachers. I applaud your bipartisan work with Senators Bingaman, Mikulski, and Domenici on the PACE Act and I look forward to working with you on these issues. I join in welcoming Assistant Secretary Luce and our other witnesses today, and I look forward to their testimony.

In today's competitive global world, America's ability to produce talented scientists, mathematicians and engineers is vital to our economy and our national security. To stay on the cutting edge of innovation, we need to educate and train a new generation of students who excel in these fields. It's no surprise that every major report on the global challenge calls for increased investment in teaching as one of the main solutions.

The most powerful predictor of student achievement in math and science is teachers who are fully certified and have at least a bachelor's degree in the subject they teach. According to the National Science Board, however, as many as 28 percent of science teachers and 20 percent of math teachers lack full certification in their teaching field.

Low salaries and insufficient support make it extremely difficult to recruit and retain highly-qualified teachers. Teacher salaries

have remained nearly flat over the past decade. Almost a quarter of science and math teachers who left the profession between 2000 and 2001 reported that they did so for better salary and benefits in other careers.

Teachers also need resources and training to inspire students to achieve at the highest levels. Schools need tools, such as good textbooks and modern laboratories, to help students commit to these subjects. For America to remain competitive, we need a significant and sustained increase in investment in teachers.

Given the scope of the challenge we face, the administration's proposals in the new budget are far from enough.

The President's Adjunct Teacher program has the potential to provide students with valuable role models who can teach them real-world applications for the skills they are learning in the classroom. But every teacher must be well qualified—and have a degree in the field they teach, as well as a State license and certification.

According to the Department of Education, we're only half way there today. Only 54 percent of the Nation's middle and high school teachers meet these requirements. The professionals in the President's Adjunct Teacher Corps are important resources, but they are no substitute for highly qualified teachers.

This proposal also falls short because it does not include funding to help teachers strengthen their skills. The Math and Science Partnerships in the No Child Left Behind Act and at the National Science Foundation develop teacher skills and train teachers in the best instructional techniques, but the partnerships have been chronically under-funded. Two years ago, the President even proposed eliminating the NSF program. We need to invest more in these programs that educate and train existing teachers, not abandon them in favor of others that can reach only a small number of teachers and children.

We must also do more to put the best teachers with the children who have the greatest need. Students in high poverty schools today are more likely to be taught by inexperienced teachers. It's unacceptable that in high schools with large minority student populations today, 41 percent of teachers lack an undergraduate degree in their primary field of instruction. All students have the right to expect their teachers to be well-trained and knowledgeable.

This week, I am introducing the New National Defense Education Act, which makes investment in teachers a priority.

- The bill makes college free for persons studying to become math, science and critical-need foreign language teachers who agree to teach in high poverty schools;
- It provides grants for innovative postsecondary programs to recruit more teachers to these fields;
- It offers financial incentives, including tax breaks and increased loan forgiveness, to attract high-quality math and science teachers to high-poverty schools;
- It creates a multi-year summer institute through the National Science Foundation to help teachers improve their teaching skills in math and science; and
- It helps high-need schools build modern laboratories and buy new textbooks, so that teachers will have the support they need to help children succeed in the 21st century.

The demands of globalization mean we must develop the capacities of all our people, but we can't do it without a sustained commitment to investing in our teachers. I look forward to hearing from our witnesses today and to working with them and the committee to see that America maintains its competitive edge by strengthening our greatest resource—our people.

Senator ALEXANDER. I am going to ask you to testify, if you will, in the following order that I introduce you, starting with Dr. Vagelos, who is a member of the Augustine Committee that produced "The Gathering Storm," which is the base report that is the basis for the PACE legislation. He is the retired Chairman and Chief Executive Officer of Merck. Merck's own Science Teachers Institute was recommended by the Augustine report as one example of a good short-term academy for teachers.

Following Dr. Vagelos, Dr. Mary Ann Rankin, who is the Dean of the College of Natural Sciences at the University of Texas at Austin. She was the driving force behind the acclaimed UTeach program, which is also included in the PACE legislation.

Dr. Hai-Lung Dai is the Director of the Science Teachers Institute at the University of Pennsylvania in Philadelphia. That institute was cited in the Augustine report as a model for a Master's degree program to help current teachers improve their expertise in science.

Ms. Veronica Garcia is the Secretary of Education for the State of New Mexico and the former Albuquerque School District superintendent. As Secretary, she has emphasized strong math and science standards, collaborated with the two national laboratories in New Mexico to improve math and science education, and strengthened Advanced Placement opportunities for New Mexico students. Senator Bingaman and Senator Domenici are the principal cosponsors of the PACE legislation and, of course, very proud of your work in New Mexico.

Ms. Delores Flanagan is a teacher at Burr Middle School in Hartford, CT, a former Teacher of the Year and certified by the State of Connecticut as a math and science mentor, a certified collaborating teacher, and also a math teacher portfolio scorer.

So may I suggest beginning with Dr. Vagelos and then to Dr. Rankin, as you were introduced. You have submitted your testimony. It will be included in the record. If you could take up to 5 minutes and summarize your testimony, then that would give us a chance to ask you questions. When the time comes for asking questions, since Senator Bingaman hasn't had a chance to ask any questions, we will let him go first, then we will go to the Republican side.

Dr. Vagelos.

STATEMENTS OF P. ROY VAGELOS, RETIRED CHAIRMAN AND CHIEF EXECUTIVE OFFICER, MERCK AND COMPANY, INC., AND MEMBER, COMMITTEE ON PROSPERING IN THE GLOBAL ECONOMY OF THE 21ST CENTURY, COMMITTEE ON SCIENCE, ENGINEERING, AND PUBLIC POLICY, DIVISION ON POLICY AND GLOBAL AFFAIRS, THE NATIONAL ACADEMIES, BEDMINSTER, NJ; MARY ANN RANKIN, DEAN, COLLEGE OF NATURAL SCIENCES, UNIVERSITY OF TEXAS AT AUSTIN, AUSTIN, TX; HAI-LUNG DAI, DIRECTOR, PENN SCIENCE TEACHERS INSTITUTE, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA; VERONICA GARCIA, SECRETARY OF EDUCATION, NEW MEXICO DEPARTMENT OF EDUCATION, SANTA FE, NM; AND DOLORES FLANAGAN, TEACHER, BURR MIDDLE SCHOOL, HARTFORD, CT

Mr. VAGELOS. Thank you, Senator Alexander and Senator Isakson and Senator Bingaman. I am delighted to be here. I am happy to have the opportunity to discuss the recommendations of the National Academies Committee on Prospering in the Global Economy of the 21st Century.

In your letter to me, you asked for the committee's best methods for preparing future math and science teachers to fill the pipeline of qualified individuals. I want to admit to a bias. I am a biomedical scientist, having headed the Merck research laboratories at the time that the statins were discovered and developed in the United States. The statins are drugs such as Mevacor, Zocor, and Lipitor, which lower blood cholesterol. These drugs have revolutionized the treatment of heart disease in the world. That invention could have been made outside of the United States except that the scientists in the United States at that time were prepared to work in this field and were able to take advantage of it for the benefits of the world, really.

Our committee believes that our children's understanding of science and math will be crucial for the United States to retain high-knowledge jobs in the 21st century. That is what we are talking about, of course. The committee noted that the majority of K through 12 teachers now teaching in math and science do not have majors and have no certificates in those areas. In the year 2000, 61 percent of the teachers teaching chemistry and 67 percent of teachers teaching high school physics did not have a major in that area, so they don't really have a fundamental understanding of the things that they are teaching and that is not a good thing for us.

The committee has as our top recommendations improving the content knowledge of the teachers teaching both science and mathematics. The first recommendation really speaks to the UTeach program, which will be discussed in some detail by Dr. Mary Ann Rankin, but this program, we find, is really outstanding because it takes people who really will be majoring in the subjects of note and during their 4-year exposure period will also take some pedagogy studies. When they graduate, they will fundamentally understand these subjects, the content and also teaching, and will go out to the community. The idea, the proposal is that they get up to 4 years of scholarships to do that and universities are also given payments in order to formulate these programs.

The second one is the science and math Master's program at the University of Pennsylvania, which Dr. Hai-Lung Dai is going to discuss. This one is taking current teachers back into the universities for a 2-year concentrated program, part-time. They continue working, but they spend three summers and alternate Saturdays, where they again spend 80 percent of their time on content of a science or math and 20 percent on pedagogy. At the end of that time, they are the Master Teachers. They are the teachers who really understand these subjects and will be able to tutor in all the other programs, the summer programs, the institutes.

And so we see these as the two long-term programs that are going to produce the kinds of teachers that we should have throughout our system and they are very critical. Then we have the shorter-term proposals that will have immediate impact and they include the summer institutes, 1, 2, 3, 4 weeks, which would give concentrated, again, content studies for people coming in from the current teachers in K through 12.

An example is the program in the K through 6 in math and science, and you would say, well, why K through 6? Well, because many students are turned off by teachers who are afraid of math and afraid of science and we lose them right at that early age. So we have a K through 6 program that we are promoting.

Another recommendation is the Advanced Placement program, which will be discussed by Peter O'Donnell tomorrow, but here, too, current teachers being brought back for a couple of weeks to learn to teach to the Advanced Placement courses. These teachers will have incentives. The students will have incentives. The program seems to work pretty well in Dallas and we are strongly behind that.

So we have the combination of short-term programs and the long-term programs, which we think are fundamental. We are promoting both of them. We think they should go hand-in-hand to bring our country to where it should be.

You asked also how this relates to the PACE proposals, and they are right on, of course. We are delighted that you have taken that initiative, you and your committee, to propose such legislation which contains both the long-term and the short-term remedies for our problems in science and math and will bring us to a competitive position.

Thank you.

Senator ALEXANDER. Thank you, Dr. Vagelos.

[The prepared statement of Mr. Vagelos follows:]

PREPARED STATEMENT OF P. ROY VAGELOS

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 (collectively known as the National Academies). The National Academies were chartered by Congress in 1863 to advise the Government on matters of science and technology.

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 and mathematics education are the committee's top priority.

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

• In 1999, 68 percent of U.S. 8th grade students received instruction from a mathematics teacher who did not hold a degree or certification in mathematics.[1]

• In 2000, 93 percent of students in grades 5–9 were taught physical science by a teacher lacking a major or certification in the physical sciences (chemistry, geology, general science, or physics).[2]

• 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 mathematics or America's ability to compete in the global economy will be diminished.[3]

The committee then made the recommendation we call "10,000 Teachers, 10 Million Minds" which proposes increasing America's talent pool by vastly improving K–12 science and mathematics education.

In developing its action steps to reach this goal, the committee first focused on what part of K–12 science and mathematics education was of greatest concern. The committee immediately recognized that many of the teachers of these subjects do not have sufficient education in these fields, and its recommendations respond to that concern.

Today, I will focus on the committee's proposed actions related to improving the quality of our teachers. Tomorrow, Peter O'Donnell, another member of the National Academies committee, will discuss the committee's proposed actions related to enlarging the pipeline of students who are prepared to enter college and graduate with a degree in science, mathematics, engineering, or computer science.

Of all its 20 action steps, the committee's highest priority is a program that would annually recruit 10,000 of America's brightest students to the K–12 science and mathematics teaching profession. The program would recruit and train excellent teachers by providing scholarships to students obtaining bachelor's degrees in science, technology, engineering, or mathematics while gaining concurrent certification as K–12 science and mathematics teachers. They would accomplish this by taking some pedagogy courses along with their major courses. Over their careers each of these teachers would educate 1,000 students, so that each annual cadre of teachers educated in this program would impact 10 million minds.

The program would provide merit-based scholarships of up to $20,000 a year for 4 years for qualified educational expenses, including tuition and fees, and would require a commitment to 5 years of teaching service in public K–12 schools. A $10,000 annual bonus would go to program graduates working in underserved schools in inner cities and rural areas.

To provide the highest-quality education for undergraduates who want to become K–12 science and mathematics teachers, it would be important to award matching grants, perhaps $1 million a year for up to 5 years, to as many as 100 universities and colleges to encourage them to establish integrated 4-year undergraduate programs leading to bachelor's degrees in science, engineering, or mathematics *with concurrent teacher certification*.

This program, modeled after a very successful program in Texas (and which is being replicated in California), takes advantage of those people who are already in science, mathematics, engineering, and technology higher education programs and offers them the ability to get into teaching. It also incorporates in-classroom teaching experiences, master K–12 teachers, and ongoing mentoring—the combination of which produces highly qualified teachers with the skills and support to remain effective in the classroom.

Our second action step focuses on strengthening the skills of 250,000 current K–12 science and mathematics teachers through summer institutes, Master's programs, and Advanced Placement and International Baccalaureate (AP and IB) professional development programs. Each of these activities also builds on very successful model programs that can be scaled up to the national level.

In the case of the summer institutes, the committee recommends that the Federal Government provide matching grants for statewide and regional 1- to 2-week summer institutes to upgrade the content knowledge and pedagogy skills of as many as 50,000 practicing teachers each summer. The material covered would allow teachers to keep current with recent developments in science, mathematics, and technology and allow for the exchange of best teaching practices. The Merck Institute for Science Education for K–6 teachers is a model for this recommendation.

For the science and mathematics master's programs, the committee recommends that the Federal Government provide grants to universities to develop and offer 50,000 current middle-school and high-school science, mathematics, and technology teachers (with or without undergraduate science, mathematics, or engineering de-

grees) 2-year, part-time master's degree programs that focus on rigorous science and mathematics content and pedagogy. This program's master's teachers would provide leadership for all the programs included in our K–12 science and mathematics education recommendation. Teachers who complete this program would receive federally-funded $10,000 stipends annually for up to 5 years provided they remain in the classroom and engage in teacher leadership activities. Once the 5-year limit has been reached, teachers could pursue national certification for which many States offer a financial basis. The model for this recommendation is the University of Pennsylvania Science Teachers Institute.

In the case of AP, IB, and pre-AP or pre-IB training, the committee recommends that the Federal Government support the training of an additional 70,000 AP or IB and 80,000 pre-AP or pre-IB instructors to teach advanced courses in mathematics and science. Assuming satisfactory performance, teachers may receive incentive payments of up to $2,000 per year, as well as $100 for each student who passes an AP or IB exam in mathematics or science. There are two models for this program: the Advanced Placement Incentive Program and Laying the Foundation, a pre-AP program.

These teachers would then participate in our proposed program, which will be discussed in more depth tomorrow by Peter O'Donnell, that 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 to 1.5 million by 2010. The committee also recommends setting a goal of tripling the number of students who pass those tests to 700,000. 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.

Why are we doing this? Because many of the science and mathematics teachers who are teaching these subjects have no background in the subjects that they are teaching. It is very hard for someone who does not have a physics education to turn students on to physics, because many lack a fundamental understanding of the subject. Teachers with strong content knowledge, either through a bachelors or Masters program, who also have strong pedagogy skills and access to ongoing skills updates can be truly effective in encouraging students to enter science, mathematics, and technology fields.

The PACE legislation package is harmonious with our recommendations and proposes actions for educating a new workforce with up-to-date knowledge in science and engineering. This critical challenge spans from K–12 through doctoral and postdoctoral education. We are particularly pleased that the PACE Acts include major programs across agencies to provide scholarships for students who study science, engineering, or mathematics and concurrently earn certification and commit to teaching. We believe that the bills' programs to strengthen skills of teachers through masters programs, workshops, and training for effective Advanced Placement and International Baccalaureate instruction are excellent.

By taking the actions proposed in the National Academies Gathering Storm report, we believe that 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.

Notes

[1] National Science Board. 2004. *Science and Engineering Indicators 2004* (NSB 04-01). Arlington, VA: National Science Foundation. Chapter 1.

[2] National Center for Education Statistics (2004), Schools and Staffing Survey, 2004. "Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987–88 to 1999–2000 (Revised)," p. 10 (http://nces.ed.gov/pubs2002/2002603.pdf).

[3] 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.

Senator ALEXANDER. Dr. Rankin.

Ms. RANKIN. Mr. Chairman and members of the committee, thank you very much for this honor. This is a great opportunity to speak in favor of the PACE bill and in particular to urge support for proven, successful math and science teacher preparation pro-

grams as a part of the legislation. I think that is a very wise part of what is being proposed.

I know you share my deep concern for the threat that the inadequacies of our system of education pose to our national economy and security, and I feel very strongly that we are losing students from technology-related career paths in middle school—late elementary actually, I agree with Dr. Vagelos—middle school and high school because of a lack, of qualified, inspiring math and science teachers. I think a key part of the solution to this problem is innovative, effective teacher training such as what we have developed in partnership with the College of Education at UT-Austin.

In 1997, we initiated a program for math and science majors, which as you have heard we called UTeach. Now, Research I universities have not traditionally assumed much responsibility for teacher training, so this is rather unusual for UT-Austin, and in fact, prior to the establishment of this program, we had very few math and science majors pursuing certification. I think in 1996, we had four in science and 19 in math out of a student body of 8,300 science and math majors at the time, and it was the fall-back choice after they had not gotten into graduate school or medical school and many who were certified did not actually go on to teach.

So we wanted to create a program that would attract large numbers of strong math and science majors to teaching and, of course, to prepare them to be successful, and we believe we have achieved that goal. Since the inception of the UTeach program, we have doubled the number of math majors and increased by probably six times the number of science majors being certified. Enrollment now is 449 students this year, and this year's 74 graduates will bring the total number of graduates to about 350. Approximately 89 percent of these graduates are either planning to teach or teaching, and 75 percent of those who graduated in 2001 or before are actually still teaching. If you know anything about the rate of teachers leaving the profession, you know these are very good numbers.

The quality of UTeach students is very high. As a group, they have higher SAT scores, higher grades in comparison to the rest of the college undergraduate peer group, and approximately a quarter of these students are traditionally underrepresented minorities who we believe will be strong inspiring role models for their own students. This, again, is substantially more than in the overall UT undergraduate population.

These strong students are choosing this career path as a first choice rather than a fallback and they emerge with a lot of experience in the classroom as well as a very good grounding in pedagogy. We feel that the time has come to replicate this program across the country.

We favor the creation of an initiative that will help other universities develop programs similar to UTeach. One possibility might be a sort of a phased initiative where we target major universities that already have the capacity to prepare many secondary math and science teachers, including UT-Austin, and then in a second phase, each of these model programs could assist neighboring universities to develop their own programs. Scaling up is always a challenge, but I think at this point in time, it would be a mistake

to just try to reinvent the wheel, but rather we should take proven programs and try to scale them up and replicate them.

I think awards should be large enough to enable program establishment, but not so large as to create long-term dependence on Federal funds. The institutions that receive funds need to commit to incorporating the program and its expenses as a part of their normal operating budget after the funding is gone.

I think another probably important thing is to involve deans of colleges of science and education as PIs, who are certainly leaders in this initiative, because this is sort of where the budget is created and close enough to the faculty to actually make things happen.

The key elements of UTeach success that we feel other programs should replicate are, first of all, adherence to national and State guidelines for math and science education; employment of outstanding and experienced high school and middle school math and science teachers as instructors, advisors, and field supervisors, along with regular science and education faculty. I think this is one of the most important components of UTeach's success.

Another important thing is new pedagogy classes that replace the old traditional general education courses and focus on how you teach math and science, intermingled in a curriculum with the discipline courses and reinforcing them. Inclusion of field experiences in the pedagogy courses at every level, so the students are out experiencing teaching all the way through their program.

Aggressive recruitment of math and science majors to teaching, which involves advertising the program in many different ways and providing monetary incentives to try the program and then to be supportive while they are going through. This could take the form of scholarships, of course, but one thing that has been very important in UTeach's success is internships, where they actually work in teaching situations, being paid, in our case, with private funding, but as aides in public school classrooms, docents in museums, or other sort of situations that reinforce what they are learning in their pedagogy courses.

Also, the ability to complete the program with a serious math and science major and teacher certification in 4 years. I think that has been very important.

Finally, induction support for the graduates once they leave us. We have focused a lot on the fact that many new teachers leave the profession within the first few years of service and we think a substantial support system, online support if they are not within the neighborhood, but also assistance with visits by experienced mentors, assistance with lesson plans, curriculum, classroom management. All of this can make the difference between the first years that are intolerable and first years that are successful.

We have also developed——

Senator ALEXANDER. Dr. Rankin, I want to try to keep all the statements to about 5 minutes, if we can, so I can get the Senators' questions.

Ms. RANKIN. Just one more sentence and I will be finished. We have developed summer course work leading to a Master's degree along the lines of best practice in Pennsylvania and other places, and I think this is very important, as well, but thank you very much.

Senator ALEXANDER. Thank you very much.
[The prepared statement of Ms. Rankin follows:]

PREPARED STATEMENT OF MARY ANN RANKIN

UTEACH: A NATIONAL MODEL FOR TEACHER PREPARATION IN MATH AND SCIENCE

The UTeach program was developed at The University of Texas at Austin to help address the disturbing shortage of qualified math and science teachers that exists in Texas and beyond. UTeach graduates are mathematics and science majors (not Education majors). They are strong students and they are becoming teachers in large numbers.

Prior to the development of UTeach the College of Natural Sciences at UT Austin was producing *very* few graduates certified to teach high school math or science. **In establishing UTeach we hoped to create a program that would attract a large number of strong students to this career path as a first-choice and that would train them to be outstanding, successful teachers.**

SELECTED AWARDS FOR UTEACH GRADUATES

2006

• Elizabeth Abernathy (certified, Spring 2003) is selected as the Teacher of the Year at Kealing Middle School.

• Katie Arrington (graduated May 2001, currently in the UTeach Master's Program) is selected as Math Curriculum and Instructional Specialist in Round Rock ISD.

• Geoff Mathews (graduated Fall 2000) is selected as Technology Specialist in Round Rock ISD.

2005

• Michael Degraff (Graduated May 2005, currently in the UTeach Master's Program), teaching at Bowie High School in Austin ISD, is selected as Mathematics Chair Honored Graduate by the UT Mathematics Department.

• Dan Powderly (Graduated Spring 2003) is named Teacher of the Year at Castleberry High School in Forth Worth.

2004

• David Villalobos (graduated Spring 2001) is selected as Travis HS Teacher of the Year.

2003

• Chris Vande Sande Mihealsick (Graduated Spring 2002) is selected as Teacher of Promise for Crockett High School in Austin.

Our original aims have been met. From a pilot project with 28 students in the fall of 1997 UTeach has now matured to a high-profile, well-respected program with an enrollment of over 400 students/year. Nearly 300 students have graduated and nearly 89 percent are teaching, planning to teach, or actively searching for teaching positions. Over 75 percent of the graduates who began teaching in the Fall of 2001 or before are still teaching.

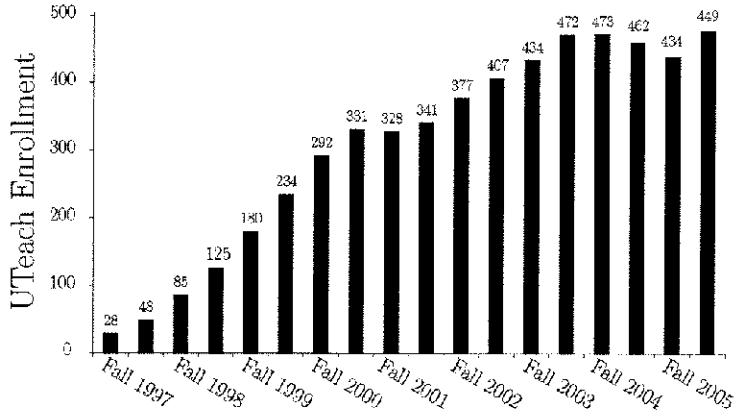


Figure 1: Growth of UTeach from 1997 to present.

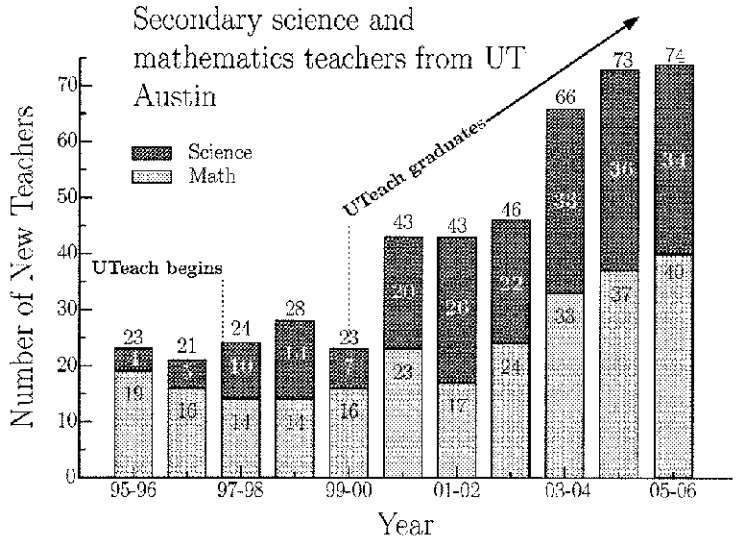


Figure 2: Numbers of majors certified to teach math and science at UT Austin from 1995 to present

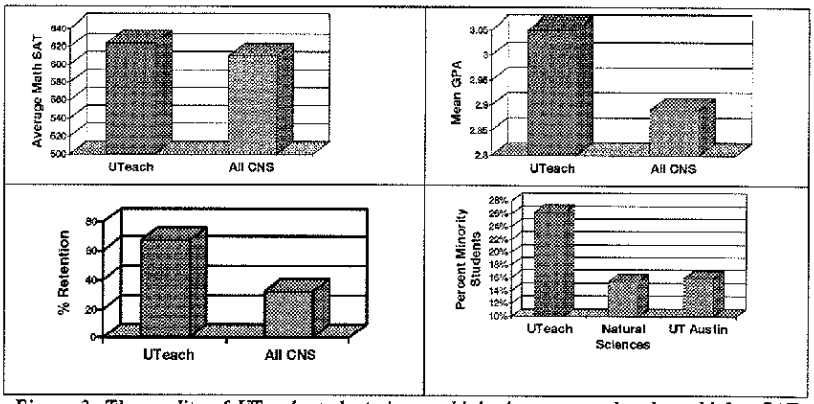


Figure 3: The quality of UTeach students is very high. As a group they have higher SAT scores, and higher grades in comparison to their College of Natural Sciences (CNS) undergraduate peer group. Approximately one-third of UTeach students are traditionally underrepresented minorities—twice as many as in the overall UT undergraduate population. Retention in the UTeach program is approximately twice as high as in the College of Natural Sciences as a whole. See http://uteach.utexas.edu for more information.

Beyond its ability to attract top students into math and science education, the success of UTeach can be measured by its increasing stature as a model program for teacher preparation in which colleges of science and colleges of education work together with public schools. On the UT-Austin campus, the College of Liberal Arts has implemented its own version of UTeach. The UT System has declared UTeach to be a part of the *Every Child Every Advantage* initiative,[1] and the National Research Council[2] and the U.S. Department of Education[3] have cited it as a model program. Texas A&M has implemented a program similar to UTeach after several discussions with us. Many other institutions in Louisiana, Colorado, and elsewhere are exploring ways to create similar programs. Indeed, to bolster its long-term economic prospects, which are largely dependent on the availability of a workforce with science and math skills, California has embarked upon an initiative to improve teacher preparation and increase the number of certified math and science teachers graduating from its public universities.[4] The reform is based upon the UTeach model developed at UT Austin and is statewide in scope, with the full backing of the Governor. This is an effort to quadruple California's annual production of credentialed science and mathematics teachers, from 250 per year to 1,000 per year by 2010. This initiative is the largest of its kind in the Nation and although it has just begun, it is an example of the level of commitment that will be necessary to solve the teacher shortage problem.

The following characteristics of UTeach have proven to be extremely important in attracting, retaining and successfully preparing large numbers of outstanding math and science majors for the teaching profession:

• Experienced, outstanding former public school math and science teachers (Master Teachers[5]) have been hired by the College of Natural Sciences as non-tenure-track faculty (at this time we have 8 on staff), paid from the instructional budget to supervise field experiences and teach certain associated classes. They are tremendous role models for apprentice teachers; being knowledgeable about what new

[1] www.utsystem.edu/EveryChild/K16PrgDes-Initiative1.html.

[2] *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium*, National Academy of Sciences Press, (2000); *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academy of Sciences Press (2005).

[3] www.ed.gov/news/speeches/2004/03/03182004.html; www.uteach.utexas.edu/about/recognition/Title11Report03.pdf.

[4] http://www.universityofcalifornia.edu/academics/1000teachers/.

[5] A Master Teacher is an individual with at least 3 years public school teaching experience whom has put into practice the instructional strategies on which we will be evaluating UTeach students. Master Teachers are tremendous examples and guides, they are knowledgeable about what new teachers really face and need, and they are indispensable in providing connections with local school district teachers and administrators.

teachers really face and need, they supply real life experience, guidance, and inspiration. They have been essential in providing connections with Austin school district teachers and administrators. They model excellent teaching practice for the UTeach students and the UT-Austin tenure-track faculty.

• Early positive teaching experience gets students interested in the program. In their first program semester, UTeach students have carefully supervised field experiences in public school classrooms using research-based instructional materials that give them successful but realistic teaching experiences, and let them judge whether teaching is a good personal choice. The first two UTeach courses are field experiences in Austin elementary and middle school classrooms guided by inspiring, veteran teachers. This experience typically creates satisfaction and a commitment to teaching in participating students. The introductory courses are *offered at no cost* to the students. Although this is not a great savings, it seems to be important in convincing students to participate.

• *Innovative new professional development courses have entirely replaced the old education curriculum*. The new courses focus on new theories of learning and on how to teach science or math effectively to diverse learners. They combine content material and pedagogy, are integrated with science and math courses, and emphasize the connections between the sciences and between mathematics and the sciences. Students acquire expertise with instructional technology through experiences woven throughout the pedagogy courses and learn how to use technology effectively in teaching. UTeach instruction models teaching practices expected of its graduates, emphasizing the use of inquiry and technology to engage students more deeply in learning mathematics and science. There are no generic education classes.

• UTeach was designed in consultation with a group of outstanding high school teachers and the State Board for Educator Certification, according to new State guidelines for teacher certification, and new national and State standards for K–12 education in math and science.

• All students in the College of Natural Sciences are recruited to join UTeach. We invite the whole freshman class to participate; letters of invitations go to new students before summer orientation followed by a presentation during orientation and additional invitations via mailings each year. Students also hear about the program through presentations to students groups, posters, and newspaper and television reports.

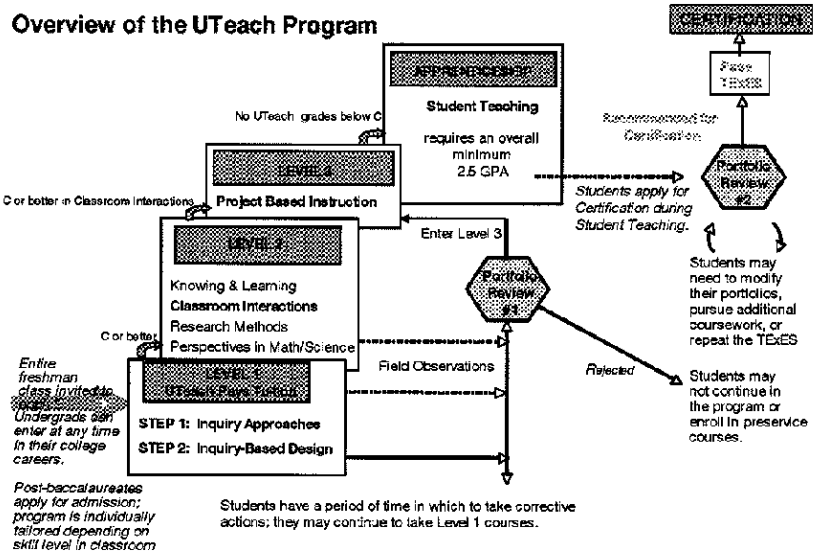
• Field experiences in AISD high school or middle school classrooms continue as part of the pedagogy courses under strong mentor classroom teachers, and with guidance from the UTeach master teachers. This further increases the positive reinforcement that good teaching experience provides and gives valuable practice in teaching. Since nothing enhances learning of a subject more effectively than teaching it, the field-oriented pedagogy courses reinforce mastery of the discipline. Every student receives detailed written commentary on his or her teaching from cooperating teachers, and whenever possible from course instructors and Master Teachers. Lessons may be videotaped to provide opportunities for further analysis and reflection. All cooperating public school teachers who mentor UTeach students are paid for their efforts. All lessons taught by UTeach students in the field are based upon carefully prepared lesson plans that are available for review by course instructors, Master Teachers, and cooperating teachers prior to delivery.

• Student teaching is the final field experience and it is overseen by Master Teachers through the college of Natural Sciences. Mentoring and help, either online or in person, continues even after students graduate and begin teaching. All UTeach students complete a portfolio that documents their accomplishments according to the State standards and additional UTeach program requirements. Final evaluation of teaching proficiency is done by trained observers, based on the candidate's classroom performance.

• UTeach is a 4-year program. Students can finish in 4 years with certification, having completed a strong degree program in mathematics or science with student teaching. Therefore students can obtain teaching certification without expending money or time beyond a normal undergraduate degree.

• UTeach degree plans are available for all teaching certifications grades 4–12 involving science, mathematics, and computer science. They are constructed with attention to State and national standards for teacher preparation in each discipline, including both process skills and content items. All the competencies of teachers required by the State, and assessed by the portfolio and final observation are covered during the UTeach course sequence. We also allow professionals to change careers and become teachers in an accelerated program that strikes the right balance between getting them into the classroom quickly and preparing them well enough so that they stay.

• All UTeach students have a research experience to expose them to the challenges of open inquiry and technical accomplishment that characterize investigations in science and mathematics and to teach them how to facilitate such experiences for their own students.



• Internships and scholarships are available for students who need them. Internships are funded from private donations solicited by the college; they provide financial help in an educational setting, augment student training and field experiences, and maintain commitment. Sixty to ninety students per semester work in nonprofit educational settings. Tasks range from mentoring children in math and science outreach activities or assisting in Austin public school classrooms, to working in museums or preparing educational software.

• UTeach is a partnership between Colleges of Education and Natural Sciences (although the students are all Natural Sciences majors). This may not be essential but has been an important element of success at UT-Austin.

• The fact that this program developed at a Research 1 University means that very strong math and science students are involved in the program and we are able to infuse the program with an understanding of research and analysis as the foundations of science. The program could be replicated at non-R-1 universities and colleges, but a less well-prepared student body or faculty might mandate some enrichment activities in the discipline courses in order to have the level of discipline preparation that is characteristic of UTeach students.

Another critical concern is support for our UTeach graduates and other novice science and math teachers. Many new teachers leave the profession within their first 2 years of service. We believe that a substantial support system, including assistance with lesson plans, curriculum and advice on classroom management can make the difference between first years that are rewarding or intolerable. To address this difficult problem we have developed, with support from the Michael and Susan Dell Foundation, a scalable, sustainable support system for novice math and science teachers. It involves onsite visits by experienced mentor teachers combined with 24–7 online help and on-demand Saturday workshops. We are also developing summer coursework leading to a Master of Arts in Science and Mathematics Education. We have established a graduate-level program of professional development that will lead to a UTeach Master of Arts in Science and Mathematics Education. This provides the context of an advanced degree path for our new-teacher mentoring program and will hopefully be an added incentive for our novice teachers to continue teaching. It will also provide a rigorous, practical, high-profile path to a master's degree for in-service teachers across Texas. We believe the mentoring-to-masters continuum will enable participating teachers to develop from novices to seasoned professionals, and will provide more established teachers with practical opportuni-

ties for real professional renewal. For Texas this will mean more and stronger teacher-leaders in mathematics and science throughout the State.

Funding for the program comes primarily through university resources. About $1.5M/year pays the normal costs of University instruction. However, some aspects of the program such as the internships, tuition for the first two courses, and the induction support for new teachers require private funds, and many private foundations and individuals have provided support since 1997. We are working to establish an endowment to permanently support these kinds of expenses and have raised over $7 million towards a goal of $15M. The income from this endowment as well as additional one-time funds from foundations and individuals augments The University of Texas support for the program.

Replication of UTeach

The time has come to implement the UTeach model across the United States. At UT-Austin, where UTeach was pioneered, the number of secondary science and math teachers certified per year has increased dramatically since inception of the program. Now is the time for science, math and education faculty and administrators at other research universities to develop the same level of involvement in teacher preparation that has made UTeach a success.

The improvement of teacher preparation calls for programs that are effective, and based upon experience. Effectiveness needs to be valued more highly than novelty in this situation, and cooperation between institutions valued more highly than competition. Thus we recommend an alternative to the traditional merit review process.

A program aiming to affect most of the country's large public research universities could proceed in phases. A first phase might be to identify universities that already have the capacity to prepare many secondary mathematics and science teachers, and whose programs are largely consistent with the provisions outlined above. These universities would complete the process of developing model programs, and develop the capacity to assist other universities to do the same. UT-Austin would welcome the opportunity to share the strategies used to develop UTeach during this phase, and would be glad to improve UTeach through interactions with other universities. In a second phase, each of the model programs in phase I would assist universities in geographic proximity to develop their own new programs. A third phase should be sufficient to affect public universities willing to participate, and private universities willing to offer competitive opportunities. Universities not interested in participation might be persuaded by the successes in the first two phases. Principal Investigators should be Deans of Arts and Sciences and co-PI's should be Deans of Education. Deans retain enough contact with faculty and departmental issues to ensure program implementation but are high enough in the administrative hierarchy of most universities to effect permanent change.

We suggest that replication awards be for 6–8 years, focused on creation of teacher preparation programs on the UTeach model. Suggested requirements for a successful application appear in Appendix 1. Successful applicants would be reviewed annually. Continued funding for the full term would be tied to progress on specific benchmarks.

Funds should be granted on a annual basis, subject to review and successful completion of benchmarks for enrolling and graduating students, creating courses and degree plans, and employing staff. Note that an important component of the program is the adoption of teacher preparation as a *well-supported, permanent part of normal university operations*. Therefore the grants should be set at a size designed to *enable a new program to begin, without creating dependency that threatens the program when Federal funding terminates*. Appropriate uses of grant funds include hiring Master Teachers, employing support staff, summer salary for participating faculty, or funds for student recruitment such as tuition remission. In any successful program, costs will rapidly exceed the amount of the grant. *Deans, Provosts, and Presidents must therefore be aware of the commitment they are making as the process begins*. Specific, explicit commitments on the part of the central administration *should be required* as a condition of participation in the form of an MOU. Potential for additional State support for a program should be part of this planning process.

In endeavoring to establish UTeach-like programs at other institutions, we must take into account differences in administrative structure, mission, location, and student population. For example, one hallmark of UTeach is the excellence of the math/science knowledge that UT-Austin graduates possess, as evidenced by their high scores on certification exams and their classroom performance. If students do not enjoy the same degree of preparation in their discipline as UT-Austin College of Natural Sciences majors, it may by necessary to enrich the science and mathematics curriculum at their universities. This would require additional funding. We have developed a program at UT-Austin focused on at risk students admitted under Texas

House Bill 588 passed in the 75th legislature that granted automatic admittance to all high school graduates in the top 10 percent of their graduating class to any Texas public college or university. This program, called the Texas Interdisciplinary Plan, is described in Appendix 2. It emphasizes enrichment activities, mentoring, small class sizes and work on applied problems. It has been very successful at UT-Austin, fits well with the UTeach curriculum, and could be adapted to augment basic math and science programs at other universities. Similarly, UT-Austin is located in a large metropolitan area that affords many and varied classroom experiences for our students. This has been extremely important to the success of the UTeach program. Universities located in more rural settings will face special challenges with respect to providing field experiences for pre-service students, and we would need to find ways to address this issue to achieve maximum success in these regions.

In summary, we seek to help create an initiative that will assist other universities to develop programs similar to UTeach that redefine how math and science teachers are trained. We suggest the creation of a Federal initiative with a goal of enabling institutions across the country to increase the number and **quality** of science and mathematics majors obtaining teacher certification with funding dependent upon incorporation of the elements of success that we have demonstrated in the UTeach program. Providing scholarships to students attending traditional programs is insufficient to produce the type of teachers needed to lead more students to careers in math and science. It is critical that any Federal initiative serious about transforming math/science education in the United States include funding for institutions to develop teacher-training programs as innovative and effective as UTeach.

PROFILES OF UTEACH STUDENTS AND GRADUATES

UTeach students come from many backgrounds and bring many different strengths to support their hopes of changing lives through teaching. These students and graduates will be glad to discuss their experiences at UT-Austin, in UTeach, and as future and current teachers.

Current UTeach Students

April Lisa Olivarez: April Lisa is a senior majoring in mathematics, who is student teaching this semester. She comes from south Texas and she and her brother were the first in her immediate family to attend college. While still in high school, she took courses at UT Pan American and South Texas College, along with math and computer science AP courses. She ranked 8th out of 614 students at Mission High School and came to UT-Austin in the fall of 2002. She is an officer in the UTeach student organization and also works with a youth group five times each week as a mentor.

Janice Trinidad: Janice graduated summa cum laude from Fordham University with a Bachelor of Science in physics. She was admitted to the UTeach program for post-baccalaureates in the spring semester of 2005. She is working as a teaching assistant while conducting research and taking coursework towards teacher certification in physics and math, the UTeach Master of Arts, and a Ph.D. in theoretical physics. She is a past and current recipient of the Noyce Scholarship, funded by the National Science Foundation.

Jenna Saldana: A sophomore mathematics major, Jenna comes from Carrizo Springs, Texas, a predominately Hispanic town close to the U.S./Mexican border. Jenna's dedication to quality education in our schools was demonstrated early in the program when she worked as a tutor/mentor in Dove Springs, an economically distressed neighborhood. Spanish is the first language for most of the students in that area. Jenna believes that her own fluency in Spanish is an asset in her work with these children. She is working towards certification in mathematics.

Tyler Ham: Tyler is a senior majoring in mathematics. For the past 3 years, he has also been a UTeach employee, working as the program's webmaster and data analyst. He graduated from Sam Houston High School in Arlington, Texas, second in his high school class of 373 students. His strong high school performance, taking AP classes in math and physics, English, chemistry, computer science, and history, has carried over into college course work. He is pursuing certification in mathematics.

Alba Esparza: Alba is a junior majoring in mathematics at The University of Texas at Austin. Originally from El Paso, she graduated from Clint High School near the top of her class, taking AP courses in mathematics. Now in her second semester with UTeach, she is working towards the goal of becoming a middle or high school math teacher.

Meagan Vickers: Meagan graduated second in a class of 99 students at Columbus High School in Columbus, Texas, a small town between Houston and San Anto-

nio. Currently, Meagan is a senior and student teaching towards her certification in mathematics. Meagan has received University Honors every semester she has been with UT.

UTeach Graduates

Ditrell Binkley: Ditrell graduated from The University of Texas at Austin in 2004 with a degree in mathematics. Though graduating first in his high school class of 360 students, Ditrell hit a few rough patches on the road to graduation from UT. He left UTeach for a couple of semesters, but a conversation with one of our Master Teachers brought him back into the program. Ditrell began teaching for Paredes Middle School in 2004. Beginning in 2005, while still at Paredes, Ditrell began work on a UTeach Masters in Math Education. Ditrell is dedicated to educational reform and intends to become an administrator.

Eliana Prada Owens: Eliana came to the United States from Venezuela in 2000. After taking courses at Austin Community College, she was accepted to The University of Texas at Austin, where she majored in mathematics. A native Spanish-speaker, Eliana was a self-motivated student, determined to excel academically. She graduated with honors in the fall of 2003. Her first teaching job was with Georgetown High School, and now she is teaching mathematics at Stony Point High School in Round Rock. Eliana has been very successful in implementing the kinds of inquiry-based learning techniques emphasized by the UTeach Program. She has been a student in the UTeach Masters in Education program at UT since the summer of 2004.

Steven Sinski: After graduating from high school in San Antonio, Steven came to The University of Texas at Austin where he earned a bachelor's degree in Biology in the fall of 2005. He is working for the UTeach program and will be searching for a teaching position in the fall.

Natalie Pickering Wieland: Originally from New Mexico, Natalie graduated in December 2005 with a Bachelor of Science in chemistry and a perfect 4.0 GPA. She received the Noyce Scholarship, funded through the National Science Foundation, and is currently teaching at Round Rock High School.

Jesse de la Huerta: Despite the difficulties of living as an English language learner while in the public schools of south Texas, Jesse graduated from Rivera High School in Brownsville ranked 7th in a class of 296 students. Jesse earned his undergraduate degree in mathematics from The University of Texas at Austin in the fall of 2004. Currently, he teaches in Austin, Texas, at the International High School, one of the magnet schools at Johnston High School, where he says he has found his calling.

Katie Weber: Katie graduated from The University of Texas at Austin in 2004 with a Bachelor of Science in Biology. She received University Honors during each of her nine semesters as a Longhorn and was a speaker at Commencement. Currently, she's teaching at Henry Middle School in Leander, TX.

David Vance Ballard: Vance came to UTeach through an unconventional route that included a stint as a deputy sheriff. He graduated from The University of Texas at Austin in 2005 with a bachelor's degree in Biology. He is now teaching for Del Valle High School in the Austin, Texas area.

APPENDIX I: Conditions for Awards

To be awarded support, a university would need to develop a plan for the improvement of teacher preparation in science and mathematics with the following elements.

- Description of current certification rate of science and mathematics teachers.
- Statement of goals for improvement with timeline describing numbers of students enrolled in program and graduating.
- Description of any existing university programs that indicate university capacity to develop teacher certification on the UTeach model.
- Identification of an organizational unit within the College of Arts and Sciences or College of Science that will adopt teacher certification as its primary mission with signed agreement from the central administration.
- Identification of core faculty in departments of science and mathematics who will champion teacher preparation in their departments by teaching courses dedicated to preparing future teachers, help create new degree plans, advise prospective students within their major, and assist as needed with program administration.
- Identification of core faculty in the College of Education who will champion teacher preparation in their departments by creating and teaching courses specific to the preparation of secondary science, mathematics, and computer science teachers and working closely with colleagues in Colleges of Arts and Sciences.

• Description of the process to be used in locating classrooms for field experiences. Supporting letters from school officials able to coordinate relations between university and school districts required.

• Description of courses to be created over the funding period, focusing on courses involving practical experience in teaching. These must involve early field experience.

• Description of degree plans existing or to be created enabling students to graduate in 4 years with a major in science, mathematics, or computer science and secondary teaching certification. Programs must make possible graduation in 4 years with certification. Post-baccalaureate programs may also be included.

• Description of schedule for hiring Master Teachers to supervise field experiences. Programs must involve former secondary teachers employed full time at the university.

• Description of other program elements, such as teaching portfolio, student support, opportunities for community service, student organization.

• Supporting letters from the Deans of Science and Education and the President or Provost of the university are required. These letters must describe the internal university resources that will be made available as the project proceeds. These include:

- Identification of space to house the new unit.
- Identification of administrative support as program grows, including administrative assistants and advisors.
- Identification of faculty and instructional lines to be committed.
- Commitment to make fundraising from private sources for the improvement of teacher preparation in science and mathematics a high priority at the university.

Note: • Letters from each faculty member, describing their interest and commitment to teacher preparation are required.

APPENDIX II: Enrichment Activities for Students With Poor Preparation for Advanced Mathematics or Science at UT-Austin: the Emerging Scholars Program and the Texas Interdisciplinary Plan

When math-challenged Calculus students are accepted into the Emerging Scholars Program they feel special and proud. Other students respect, even envy them. They do extra and harder problems than the other students rather than easier and fewer, but they do them in teams with expert guidance from specially trained teaching assistants. Emerging Scholars register for an extra course in addition to the regular Calculus class. The extra class (which meets for 6 hours a week) is run by two teaching assistants who devise hard but *practical* problems for them and help the students learn how to work them. We have a great deal of data on this program because we have run it for nearly 15 years. When they emerge from this program, ESP students are fully competitive with the other students. They move from getting D's and F's on their Calculus tests to A's and B's (see figure 1 below). An added benefit is that the numbers of minority math majors has risen steadily, because many of our ESP students have gone on to major in math! Without the Emerging Scholars Program many would not even have passed Calculus. Graduation rates are substantially higher among ESP students relative to other College of Natural Sciences students (see figure 2 below) even though this is only one course in their program. The increase in self confidence achieved with ESP has a profound impact. A similar approach works in other subjects such as Chemistry, but with modification of the enrichment material.

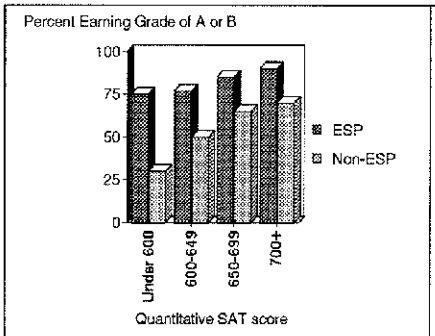


Figure 1: Academic performance of Emerging Scholars students (dark bars) at various levels of preparation as measured by entering math SAT scores, compared to non-ESP students in the same calculus courses (light bars).

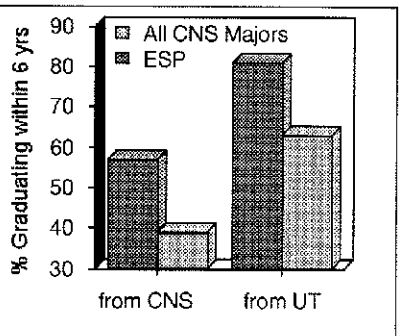


Figure 2: Graduation Rates of Emerging Scholar's Students from the College of Natural Sciences (CNS) or the University of Texas at Austin (UT) compared to the general student population in the College of Natural Sciences

The **Texas Interdisciplinary Plan (TIP)** is a broader enrichment program based upon the principles of success demonstrated by the Emerging Scholars Program. Like ESP, TIP has been developed to assist students who are likely to be at-risk in their transition to the University of Texas at Austin.[6] TIP uses many of the same techniques as ESP, particularly the extra enrichment in small groups and cohort study teams. The average TIP class size is 50 or less instead of the College average of 100, and classes are taught by instructors especially selected for their outstanding teaching record. Each basic science course has 1 to 2 hours of supplemental instruction each week in addition to a TIP seminar (see below) with a format that is similar in structure to the Emerging Scholars model. Students are personally assisted by upper class peer mentors.

Peer mentors are trained in time management, group dynamics, campus resources and services, and how to successfully assist students in their coursework. They offer academic and social guidance and support to TIP students. Selected for excellent academic performance, major, and leadership experience, peer mentors are upper division students who have themselves shown great capacity to overcome obstacles and succeed in our rigorous undergraduate curriculum. They work as academic tutors and assistants to TIP instructors and provide an introduction to UT social life through activities such as a bowling tournament in the Student Union, a tour of library services and resources, and a picnic lunch on one of the malls. Peer mentors are asked to reflect on their experiences and to continue their own training at weekly meetings with their supervisor. They play a critical role in the success of each of their TIP students.

In addition to their regular classes, TIP students attend a 3-hour seminar/workshop each week at which students are coached in strategies for achievement in their course work, good study habits, and answers to specific questions. The TIP program coordinator in the Dean's Office also organizes special events as a part of this seminar to introduce TIP students to scientists at UT and in the broader community. This immediate link of the student experience to potential future career development is important. Researchers, physicians, medical school administrators and graduate students are among the speakers. Like the additional problems sessions that Emerging Scholars students take, the TIP seminar course is at the heart of the program. It is the innovative academic venue where core course issues of immediate concern to PENS students can be aired and addressed.

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[6] TIP was created to serve a new population of students automatically admitted to the University under the top 10 percent rule. This statute, House bill 588 passed in the 75th legislature, grants automatic admittance to all high school graduates in the top 10 percent of their graduating class to any Texas public college or university. TIP participants are drawn from this pool of students and further selected for their persistence in overcoming the challenges of low socioeconomic background. The invitation is specifically worded to emphasize the rigor and special opportunities of TIP, such that students regarded it as an honor to be invited to join. Nearly all TIP students were in the top 10 percent of their graduating class, close to half are among the first in their families to attend college, many are female, and more than 60 percent are of an underrepresented ethnic minority.

In the fall of 2004 we added a TIP signature course for freshman: a *Critical Thinking Seminar* that challenges students to examine their own thinking from the perspective of rigorous intellectual standards. The seminars are kept small (approximately 20 students) to ensure a high level of student-to-student interaction. The curriculum includes two innovative student projects, including a Nobel Prize term-project and peer presentations on current issues and events.

The results of the 1999 pilot program were extremely good. TIP students had an average freshman GPA of 2.94, compared to 2.6 in the control group. They also had many fewer students on academic probation (6 percent compared to 23 percent). It is important to emphasize that these students took classes that were just as hard as the larger sections. In some cases they took exactly the same exams, but they had extra attention and tutoring, extra work, and smaller classes. They scored better *despite having an SAT a full 200 points below the college average*. Success was achieved despite taking a *more rigorous curriculum* (three math and science courses instead of the more common two) than the typical incoming CNS student. More recent results from academic year 2004–05 are summarized below.

TIP freshmen are academically more successful during their first semester at UT. This trend has been consistent over the past several years.

Fall Grade Point Average	TIP	Control
Life Science	3.01	2.53
Computer Science	2.81	2.43

TIP freshmen are four times less likely to be on academic probation, independent of their gender, race or first generation status.

% on Probation Spring 2005	TIP	Control
Life Science	5%	19%
Computer Science	0%	26%

TIP students are almost twice as likely to graduate from the College of Natural Sciences as non-TIP students. Twenty-nine of the original 1999 cohort (N=46) have graduated from UT Austin with an average GPA of 2.91. Of these students, 72% graduated in the College of Natural Sciences while only 42% of control students graduated in the College.

The TIP model provides some important lessons with respect to developing a successful UTeach program at Universities and Colleges where the student population is less well-prepared than students at UT-Austin. We expect that an enrichment program with focus on mentoring, application of coursework to workplace settings (this is a natural consequence of the field experience that is a part of many of the UTeach pedagogy courses), small class size and enrichment activities will be necessary and effective in producing teachers who are extremely well-prepared in their discipline.

Senator ALEXANDER. Dr. Dai. As I mentioned earlier, we will be glad to incorporate in our record any statement that you have today or any afterthought that you have. Dr. Dai.

Mr. DAI. Thank you, Mr. Chairman, members of the committee. It is a great pleasure for me to be here to speak on the importance of the content knowledge for teachers.

Indeed, we have a serious problem in science education. I have a personal testimony here. Nearly 30 years ago when I first came to this country as a graduate student, I was one of the five foreign students in a class of 70. But today, more than 60 percent of the graduate students enrolled in American graduate schools are from abroad. Even at one of the top research universities, like the University of Pennsylvania, in the physics department and engineering

schools, 75 percent of the graduate students are from abroad. One has to ask, where are the Americans, this question.

As the previous speakers alluded to, we have to challenge this problem head on at early education. One of the important contributing factors to this issue is teacher quality. About a month ago, the National Science Foundation called a meeting of about 400 educators, scientists, and teachers together in Washington, DC on the issue of teacher quality. The number one criterion that was identified unanimously by all the attendants for an effective teacher is content knowledge, and yet content knowledge is exactly the most serious problems of the American teachers.

First of all, there is not enough—teachers often were not prepared in the subject area they are teaching, as Dr. Vagelos suggested in the statistics, and also there is a very serious teaching out of field problem.

So how do we deal with this problem? We have heard that there are many professional societies and organizations that have proposed workshop-type summer institutes or programs. These programs are very effective professional development vehicles to enhance the teacher's teaching skills and knowledge if they already have a substantial content knowledge base. But for those teachers who do not have the content base at the beginning, then these teachers really need a very formal degree learning environment to build this basis.

So in the year 2000 at the University of Pennsylvania, with primarily small support from the National Science Foundation and the scholarship provided by the University of Pennsylvania, we started a Master's of Chemistry Education program. This program is designed with the following emphasis. It is content-intensive. Eighty percent of the courses, eight out of the ten courses are content knowledge. Full scholarship is provided, so the teacher is not burdened with financial problems. And also, the classes are given in summer as well as weekends, and so the teachers can take time and then really do this very intensive program.

Last year, with the support of the National Science Foundation, we also started a new program for the middle school teachers. This is called the Integrated Science Teacher Program. It is important to recognize that in middle school today, teachers are required to teach integrated fields of science, including physics, biology, chemistry, and also earth science, but yet even these content-prepared teachers, when they were in college, they were primarily majoring in one of the fields. So we designed this program specifically for middle school teachers with courses covering all the fields I mentioned.

I have to say that the teachers' response to our programs are very enthusiastic. They actually are the people who recognize the importance of content preparation in their dealing with students. They need to feel confident themselves before they can transmit the confidence about teaching science, complex science issues, to the students.

We have teachers who would drive hours from Central Pennsylvania, Northern Jersey, and Maryland to attend classes in Philadelphia. We even have a teacher who would take a sabbatical from Oregon to come to Philadelphia to do this program.

I will tell you a little bit about it. Of the 120 teachers so far admitted to the program, more than 72 percent did not have chemistry education prior to attending program. Also, they all are required to teach chemistry in their schools.

The school districts are also very enthusiastic. We have 36 school districts now in formal partnership with ours in running this program.

I see the red light, so I know my time is up. I would just say that this kind of program, if one were to replicate it in other places, it is important that we have these programs to have a financial incentive for the teachers so they can attend the classes. Time—they should be conducted at the time that is not interfering with their teaching duties. There should be financial incentives for the institution of higher education to participate in this kind of effort. And finally, the State and local school districts can also participate through teacher certification requirements to encourage the teachers to participate.

Thank you.

Senator ALEXANDER. Thank you, Dr. Dai.

[The prepared statement of Mr. Dai follows:]

PREPARED STATEMENT OF HAI-LUNG DAI

Among the many factors that contribute to the current alarming State of pre-college science education in the United States, as indicated by the poor performance in science test scores and students' low interests in pursuing science and technology related careers, is the quality of teachers teaching science in pre-college education. A major reason for the concern of teacher quality is the lack of content preparation of science, and likewise math, teachers.

Many anecdotal examples provided by students show that many students attribute their lack of interests in science to a bad teacher once in their learning experience. The reverse is equally true: A good teacher at one point during their learning may inspire interest and more importantly instill confidence in students' dealing with challenging and abstract subjects. A teacher who can teach and inspire has to be confident in the subject he/she is teaching. Without sufficient content knowledge, a teacher can hardly possess such confidence.

For short of content-prepared teachers, "teaching out of field" has been identified by the education community (see works by Richard Ingersoll, Graduate School of Education, University of Pennsylvania) as an increasingly problematic and important practice in math and science education within the last decade in American high schools. A casual survey of the 80 or so freshman at the University of Pennsylvania in 2004 and 2005 who intended to major in Chemistry and Biochemistry showed that nearly all of them had taken AP chemistry in high school but nearly half of them were taught by teachers whose original subject of expertise were not chemistry. Often it was biology. One should note that most of these students came from schools/school districts that were deemed successful.

In 1999, a survey conducted by Penn's Department of Chemistry found that in the Philadelphia School District, a large urban school district with more than 200,000 students, there were only 37 chemistry teachers. Of these teachers, about half did not have chemistry as a major in college.

A significant reason for allowing teachers who do not have sufficient content training to teach hardcore science courses is the unique American education philosophy, championed by the famous education philosopher John Dewey, that how one teaches is more important than what one teaches. A consequence of this philosophy materialized in education practice is that teacher certification requires pedagogy training but not necessarily content training.

The other major practice that has led to the lack of content requirement in teacher certification, in the view of this observer who was born and educated through college abroad, is that in the U.S. K–12 education is a local/state matter. In most other countries K–12 education is a central government concern that involves institutions of higher education in matters related to setting curricular and standards, and thus also requirements of teacher certification. It is hard to imagine similar practices happen in local school boards involving institutions of higher education.

The State of Pennsylvania only recently established the content requirements on science teacher certification. But even this new requirement appears to be relatively inadequate in comparing with teacher certification requirements in many countries in Asia and Europe. In Pennsylvania, to be a secondary school science teacher requires 27 credit hours of study in the discipline area in college. To be a middle school science teacher requires taking only 10 credit hours of science courses in college. Basically, any students who have taken only 3 basic science courses and a laboratory may satisfy this requirement. By comparison, in Taiwan, where I grew up, and Singapore, whose students consistently scored the best in the world, a science teacher has to major in a science subject in college with an additional year of pedagogy training. A BS in science in these countries usually requires at least 70 credit hours study on science subjects. A BS degree in these countries, like in Germany and some other European countries, amounts to a master degree in the United States.

Many mechanisms have been set up to address the problem of the lack of content knowledge in science teachers. Many workshop and short-course type programs have been conducted by professional societies, institutions of higher learning, and even industries to address specific content issues that may have been encountered by teachers in teaching. These activities would be highly valuable, should the participating teachers already have a solid base in content knowledge on the subject they teach. Such solid base in content knowledge can be best acquired through organized learning in a degree program.

In 2000, the Chemistry Department at the University of Pennsylvania, in collaboration with the Graduate School of Education, launched a new Master of Chemistry Education degree program for training 20 in-service science teachers each year. This program is designed with the following features:

(1) The 10 courses in the curriculum emphasize chemistry content (8 courses) and pedagogy in science education (2 courses).

(2) Full scholarship is provided for relieving the financial burden of participating in-service teachers.

(3) The classes are conducted over 26 months: three summers (full time, each summer 2 courses) and 2 academic years (alternating Saturday mornings, 2 courses per academic year) so not to interfere with in-service teacher job functions.

(4) All courses are specifically designed for teachers. Science content is presented along with up-to-date technology. Importance of science and technology to society and humanity is included. Science content is blended in with inquiry-based teaching methods in almost all courses.

(5) A cohort system is used and a teacher resource center established to provide support for learning of the teachers and implementing reforms in their own classrooms.

This program has been supported primarily by scholarships provided by Penn, donations from local industry (such as Rohm and Hass), and a seed grant from the National Science Foundation.

In 2005, with substantial new funding from the NSF through the Math and Science Partnership Program, the Penn Science Teacher Institute was established with the continuing MCE program and a new Master of Integrated Science Program aimed at training in-service middle school science teachers. The latter program involves courses offered in Biology, Environmental and Earth Sciences, Mathematics, and Physics, in addition to Chemistry and Science Education. Now every year, 40 new teachers are trained through these programs.

Teachers' response to these programs as a form of professional training has been very enthusiastic. Many teachers do recognize the importance of content preparation and are willing to commit major effort and time to gain this content knowledge. Many teachers drove hours from central Pennsylvania, Northern Jersey, and Maryland to attend classes. One teacher from Oregon even took sabbatical time and summers to complete the degree. After 6 cohorts (120 chemistry teachers admitted), the MCE program still has a 2-1 application to admission ratio. Here are some quotes showing how teacher graduates feel about the impact of this program on their teaching:

"Knowing the subject more makes teachable moments more common." "If you know the subject, you find the subject in everything." (From a teacher whose college major was political science.)

"I feel my content base is much better. Although I came to the MCE program with a fairly solid chemistry background, I feel much more knowledgeable in current chemical research and I definitely have a much better organic and inorganic chemistry base. I have also implemented a great deal of environmental chemistry issues into my classroom." (From a teacher who had a chemistry degree sometime ago.)

"I was not a lab person. But the labs we did in Organic and Chem. Ed really helped me to change my attitude toward lab. As a result of these courses, I started to incorporate more labs in my lesson plans. I made sure that I discussed observations that my students make at the macro levels and I also explained the reactions that were taking place at the micro level."

Many of the teacher graduates have become teacher leaders in their schools:

"Last year I lead a professional development for my colleagues. I demonstrated how to use the Penn Instructional model with a group of students. I also presented a short report at forum for K–12 educators at Bryn Mawr College. I discussed how MCE has enhanced my teaching."

"After my first summer in MCE, I was asked to give a presentation to the faculty at my school on the use of PowerPoint in the classroom. Additionally, I was asked to make a presentation last summer on the use of the PIM for lab work. This presentation was part of a teacher's summer workshop at Villanova University."

"I am conducting a professional workshop on safer chemical laboratory exercises later in the year sponsored by an EPA grant that I received through Rutgers University."

Of the 120 teachers admitted into the MCE program so far, at the time of admission all of them were teaching or designated to teach chemistry. Seventy-two percent of them did not have chemistry as either a major or minor of study in college. Most of their majors were in biology and science education, some in other science and engineering disciplines, and a few in social sciences or humanities. Only 15 percent had chemistry as a major and 13 percent as a minor in college. The problem is most serious among our urban school teacher-participants where nearly all of them did not have chemistry as a major in college. Even among our nonurban school teacher-participants, more than half did not have chemistry as either a major or minor in their college studies.

The response to these degree programs from the School Districts has been highly positive as well. Philadelphia School District has played an important role in early discussion that led to the organization of the Institute and encouraged its teachers to apply to this program. Thirty-six schools/SD's in the greater Philadelphia area are now formal partners with the Institute in that they not only send teacher participants to the degree programs but also supervisors of the teachers to the Institute's Administrator Academy workshops aimed at providing assistance in science education in schools.

From these teacher participants, quite a few interesting observations were made. We found that even among chemistry teachers, in addition to the lack of chemistry understanding there has been a serious math phobia. Most teachers before entering the program cannot handle slightly complex mathematical operations that are needed in their classroom. It is not hard to imagine that this math phobia would be highly contagious and transferable to their students. Many teachers were great problem-solvers but their ability to apply problem solving skills to the subject they are teaching were handicapped by their limited content knowledge. And then, most teachers were unfamiliar with the communication tools now commonly available in the new electronic information age such as Web site creation/edition, powerpoint presentation, etc.

It is important to recognize that for an intensive, content-based degree program to work, several ingredients are necessary: Scholarship should be provided so it does not present a financial burden to teacher participants; Classes should be conducted at times not interfering with teachers' own teaching schedule and effort; Curricular and courses should be designed specifically for teachers.

There should be financial incentives for encouraging institutions of higher education to set up or participate in such programs across the country so larger scale impact can be exerted. There should also be incentives for in-service teachers to encourage them to take on such intensive, content-knowledge based programs as means to strengthening their content preparation as well as teaching skills. States and local SD's should be encouraged to instill mechanisms or through certification process to require sufficient content preparation and renewed pedagogy training for teachers. Some States such as New York now requires teachers to obtain a master degree within 5 years of initial certification is a right direction, although 5 years may be too short to create a demanding situation for teachers to participate in a program like the MCE or MISE which takes 26 months to complete.

Finally, it is important to recognize that improving teacher content knowledge and science education pedagogy is only one important factor in the whole effort to improve students' interests and capability in science and the science literacy of the general population. Other factors such as discipline in learning and curricular requirement in pre-college education have to be considered as well. For example, in-

creasingly, at a time that AP courses are becoming more of a norm, more and more high school students now skip the basic level course and take the AP course as the only course in that particular subject area.

SUPPLEMENTAL STATEMENT OF HAI-LUNG DAI

No Teacher Left Behind

On Jan. 31, 2006, the 400 participants in the National Science Foundation Math and Science Partnership Conference on Teacher Quality identified "content knowledge" as the #1 criterion for an effective teacher. Yet the lack of content knowledge is the most serious problem affecting the effectiveness of American teachers. This problem is now widely recognized based on the impression I gathered in the hearing on Feb. 28, 2006 from the statements made by the presiding Senators and all the witnesses.

With regard to how to address this problem, there appears to have two basic approaches—one is to provide specific needs in content knowledge through short-term workshops or short courses; the other is the formal master degree program such as those provided by the Penn Science Teacher Institute that aims to build a solid content knowledge foundation in teachers.

It is important to recognize that both approaches have different purposes and aim at different audiences and should both be practiced. The short-term trainings are professional development tools for teachers who have had content training and wish to be continually educated. The degree program is needed for teachers who have not had formal training in content.

Among current teachers who are teaching chemistry, physics, math . . . in high school, likely a college level AP course, more than 60 percent of them do not have a college degree in the subject they teach. For these teachers, the short-term approach, though less expansive to conduct, will not be sufficient. An apparent analogy: each Law and Order episode may serve as a workshop training topic for a person who is interested in law. But we would not advocate a person who did not go through law school to get a license and practice law after watching 100 episodes of Law and Order.

While short term measures can be used to exert more immediate impact in improving teacher effectiveness, the longer term degree programs should be used as the primary means to address the problem in a fundamental way. The Government launched the No Child Left Behind program 5 years ago to fundamentally change the landscape of K–12 education. Now it is time to have a No Teacher Left Behind campaign to ensure the good teachers of America who struggle with the lack of content knowledge not to continue to suffer, and fundamentally change the paradigm of teacher training in this country.

Senator ALEXANDER. Dr. Garcia. Senator Bingaman, would you like to make any comments about Dr. Garcia before she testifies?

Senator BINGAMAN. Just that Dr. Garcia does a great job as head of our education effort in New Mexico and she comes here extremely well recommended. I am very pleased to have her here and look forward to her testimony, and then I have a couple of questions to ask her.

Senator ALEXANDER. Dr. Garcia, and then we will go to Ms. Flanagan, and then we will go back to Senator Bingaman.

Ms. GARCIA. Thank you. Good morning, Senator Alexander, members of the committee, Senator Isakson, Senator Ensign, and, of course, Senator Bingaman. Greetings from the Land of Enchantment. We miss you. It is good to see you.

I want to thank you for inviting me to be a part of this esteemed panel, and I do have my prepared comments, and looking at the 5 minutes and hearing your conversation, there are about six things that I want to tell you first and then I will go through my comments. In hearing your comments, you are very much on track with what we are seeing in the field and what I am seeing in our State and I just want to comment on a few things that I have heard this morning.

I have heard a need of concentrating, being able to get teachers to inner-city schools, and I have heard that term used, and I want to caution you to not stick with inner-city but think of rural States like New Mexico, where half of my districts are districts of under 1,000 kids. So high-needs schools, if that language can be there, where we look at poverty and high need, because we have some of the same challenges as you may have in the cities with inner-city schools.

I can't applaud you more for the concept of virtual classrooms. We have tried to move in New Mexico to use cyber academies and use hubs where we have the expertise to be able to teach out in these communities. I agree completely with Senator Isakson that not only does it serve to help deliver content, it also helps as a professional development tool, as well.

We are fortunate in that we have two laboratories in New Mexico, and partnering with those national laboratories and universities, I think is key.

Having been, I think, a long-term student forever, and having received all three of my degrees from the University of New Mexico, but there has always been a big divide between arts and sciences and colleges of education. I think I heard Dr. Rankin talk about that. But I think that that cannot be underestimated, that division between arts and sciences and colleges of education. Oftentimes, those professors that choose to work with colleges of education oftentimes are seen with not the same esteem as those that are pursuing research in mathematics and sciences. So we need to provide incentives so that there will be more of a motivation for professors to do that.

Then I also wanted to talk about the importance of standards. Our standards have been recognized as having more rigorous standards and higher expectations from students and that with your standards, you can include pre-algebraic concepts and actually algebraic concepts in the K through 8 curriculum so that we don't need to wait until 8th grade until we start.

So with that, I have got about 2 minutes left and I am going to hit some of my major comments that I wanted to make in my statement. First of all, I want to thank Senator Bingaman and recognize him for his leadership on this issue and for understanding the importance of quality education. You have been a real champion to us, Senator, and we appreciate you for helping us in both K–12 and postsecondary education.

We are finally getting our reform efforts moving ahead in New Mexico. As I said, we have rigorous standards that have been recognized nationally and now it is getting the teachers to teach those standards and the students to achieve them, which is certainly key, and we finally have an accountability system that is aligned.

We have two outstanding programs that we believe have helped move the math initiative forward. The Gaston Math Initiative and the Math and Science Academies are helping close the achievement gap in our State.

I also want to talk about the fact that we have a new three-tier licensure system that requires our teachers to pass basic skills in teacher competency and also that rewards teachers for higher levels of educational attainment.

New Mexico has a rich culture, with 54 percent of our students is Hispanic and 11 percent Native American. As I said earlier, we are home for national labs in Los Alamos and Sandia and we have many high-tech firms. Labs annually hire over 2,500 college students. However, while we have this great tradition of scientific discovery, we often find that we have to import people to these positions.

Our State is not without our challenges. We have high poverty. We have issues with language. We also have issues with the achievement gap. Our strong standards and rigorous teacher licensure requirements are providing the structure within which we can improve educational opportunities for our students.

I believe that in 2005, we had a Statewide math and science town hall, and I am going to leave that document for you, but many of the recommendations align with the PACE Act, which we think it will really help us. We also believe that teachers have to improve their content knowledge. I believe PACE would help New Mexico's efforts in a number of critical ways.

We also need to have teachers skilled in integrating technology into math and science classrooms. As we talk about how we are teaching our students, we also have to remember that their world is different from when we were in school and we must integrate technology more.

I can tell you also that the scholarship provision would provide great incentives for New Mexico students to become math or science teachers. And equally important, PACE provides opportunities for current teachers in the workforce to go back to school on a flexible schedule. I also believe the fellowships for teachers who graduate from these programs will go a long way in making sure our teachers get the pay that they deserve.

I know that your budgets are tight here in Washington, but I believe these provisions, coupled with the right financial support and with our efforts in our State, would make a tremendous difference in moving science and math and keeping America's competitive edge.

Thank you so much for the opportunity.

[The prepared statement of Ms. Garcia follows:]

PREPARED STATEMENT OF VERONICA GARCIA

Chairman Alexander, Ranking Member Dodd, thank you for inviting me to participate in this very important hearing. Strengthening the math and science competencies of our K–12 teachers is critically important. As clearly spelled out in the National Academies report, "Rising Above the Gathering Storm," improving the teaching skills of our math and science educators is of paramount concern to many of us.

I'd also like to thank both of you for your longstanding work on this issue, and for introducing the PACE Act. And I'd like to particularly recognize Senator Bingaman for his leadership on this issue, and for always understanding the importance of a quality education. For nearly 24 years in the U.S. Senate, he has been fighting to ensure a greater Federal investment in both K–12 and postsecondary education.

As Secretary of Education for the State of New Mexico, I am proud to say that we have made some significant progress in New Mexico in recent years. New Mexico is now widely recognized as one of the top States in the country for setting rigorous academic content standards, particularly in science and math.

New Mexico is also recognized for its rigorous teacher licensure requirements. Our prospective teachers must pass basic-skills and teacher-competency assessments, as well as subject-knowledge tests to earn their initial licenses. Our veteran teachers

must undergo performance assessments to reach a more advanced stage of certification.

As a former principal and superintendent, I can tell you how important strong standards, accountability, and rigorous teacher licensure requirements are.

Our State has a very rich culture, with 43 percent of the population Hispanic, and nearly 10 percent Native American. We are also home to two of this country's greatest National Labs, Los Alamos and Sandia National Labs, as well as many high-tech firms and industries. We have a strong and dynamic tradition of great scientific discovery.

But, our State is not without challenges. We rank among the highest in the Nation for people living in poverty. Sadly, New Mexico ranks first in the country in rural child poverty. High quality education is the key to changing this statistic. Our capacity is great, but so are our challenges.

While strong standards and rigorous teacher licensure requirements are critical, they just provide the structure within which we can improve educational opportunities. Teachers must truly understand math and science if they are to teach using the rigorous academic standards for math and science that we have established in New Mexico.

We are taking some important steps to do that. We just passed legislation to create a Math and Science Bureau within the NM Public Education Department, as well as making a significant investment for teacher professional development at math and science summer institutes. We also pushed through significant increases to improve access to Advanced Placement programs throughout New Mexico.

But we need to do more. We need to ensure that all of our teachers have the content knowledge, the math and science competencies that are necessary to teach K–12. And we need to keep these teachers in our classrooms. I believe PACE would help New Mexico's efforts in a number of critical ways.

PACE would provide New Mexico with additional tools and resources necessary to ensure that both our current and future teaching workforce have the content knowledge in math and science that our State requires. By providing grants to our universities to develop content-rich math and science education programs, our aspiring teachers will have the content knowledge necessary to effectively teach math and science at all grades, K–12.

As a former principal, I can tell you, a teacher who is knowledgeable and passionate about the subject she teaches can make all the difference in the world to a student.

And, the scholarship provisions would provide great incentives for New Mexico's students to become math or science teachers because they would cover the entire cost of tuition and other education expenses at every university in New Mexico.

Equally important, PACE provides opportunities for our current teaching workforce to go back to school on a flexible schedule, with tuition reimbursement, and earn a master's degree in math or science education.

Further, I also believe the fellowships for teachers who graduate from these programs will go a long way in making sure our teachers get the pay they so earnestly deserve. These fellowships may just provide new teachers with the compensation they need to stay in the classrooms. Also, the fellowships for the newly-minted master teachers are a great compliment to New Mexico's 3-tier licensure system, which rewards further education and additional responsibilities.

I know education budgets are tight here in Washington, but I believe if these provisions are enacted, and funded, coupled with our efforts at the State level, they very well may provide our students with the teachers they need to make New Mexico the true leader in science and technology.

Thank you for the opportunity to speak with you today.

Senator ALEXANDER. Thank you, Dr. Garcia.

Ms. Flanagan, I know Senator Dodd wanted to especially welcome you, but he is over in the Rules Committee keeping us all honest, so I will welcome you. I will give you a special welcome from him and we look forward to your testimony.

Ms. FLANAGAN. Thank you. Good morning, Chairman Alexander and members of the subcommittee. I am a middle school math teacher at Burr School, a public school in Hartford, CT. I am also a member of the Hartford Federation of Teachers-AFT. It is an honor to be here to testify on what I believe is necessary to help

prepare, train, and support our Nation's public school math and science teachers.

I have been teaching in Hartford for the past 7 years and see 125 students on a daily basis. The courses I teach include algebra, pre-algebra, and preparation for the Connecticut Mastery Test, also known as the CMT. I have made Connecticut's strict requirements to become a teacher and am considered highly qualified under the No Child Left Behind Act. I am proud to say that my students are meeting high standards in math and learning what they need to go on to higher-level math courses in high school. Becoming a highly qualified and successful teacher has been a rigorous and challenging journey, with many contributing key factors from the Federal, State, and local levels.

I was born with a love for math. This affinity for numbers became a love affair when my 8th grade algebra teacher, Mr. Fuentes, introduced me to the Connecticut Pre-Engineering Program, also known as CPEP. This one-of-a-kind program in Connecticut was established to encourage students at a young age to aspire to careers in the fields of mathematics, science, engineering, and technology. At the time, having recently moved from Puerto Rico, I was struggling with the English language but sought refuge in my success in the pre-engineering program.

That year proved pivotal after I won first place in Connecticut's Statewide bridge building competition. I knew at that point that I wanted to become an engineer and worked very hard to achieve my goal of getting into the University of Connecticut's engineering program. There were, however, some challenges. Although I graduated as salutorian of my class, English was my second language and my SAT scores were merely average. Nevertheless, I was awarded approximately $30,000 in scholarships from different agencies and foundations. UConn accepted me into its engineering program with one stipulation. My acceptance into the engineering program would only be considered upon my successful completion of its Bridge Program.

Sponsored by the School of Engineering in coordination with the Engineering Diversity Program, the Bridge Program provides a 6-week intensive summer program to prepare underrepresented students like myself for the engineering curriculum at UConn, and it worked. I was part of UConn's School of Engineering for 3 years until I began to question my purpose in life.

I thought about how my 8th grade teacher, Mr. Fuentes, had challenged and inspired me to become involved and use my talents, ability, and intelligence to take me to the highest levels. Mr. Fuentes was the catalyst in a long series of fortunate events. I wanted to have that kind of an effect on people, specifically children and young adults. I decided to apply to UConn's School of Education and I was admitted into UConn's IBM program, a 5-year integrated Bachelor's and Master's degree program. It prepares students for the real-world challenges of teaching through courses in curriculum development, assessment, and instruction, and teaching internships in both rural and urban settings. I graduated with a Master's degree in elementary education and a minor in mathematics. I also gained a cross-endorsement in middle school mathematics.

My first teaching assignment began in 1999 in a title I K–8 school in Hartford, CT. Mentors were scarce, classrooms were overcrowded, and discipline and student achievement were areas of major concern. I thought about quitting every day for 3 months. It would definitely have been easier to go back to engineering, where I would have made three times what I was making. Also, I wouldn't have been responsible for 140 fragile teenagers who had bigger problems in their lives than worrying about math or passing the CMT.

While not all engineers can be teachers, I knew that teaching was my talent and that this was not something I would walk away from. I needed help. Thankfully, Mr. William Grupp, a veteran math teacher of 23 years, became my mentor. Having a mentor and a supportive administration allowed me to focus on what really mattered. That was developing my students' math skills, challenging and increasing their intelligence, and motivating them to do their best. This support kept me in the classroom.

By my third year of teaching, I had produced a teaching portfolio that was ranked third in Connecticut and was used for teacher training purposes. My students had the highest gain in the mathematics component of the CMT in the City of Hartford, and I was given the Teacher of the Year Award. Hartford's Board of Education, the City of Hartford, and the State of Connecticut realized the importance of teacher involvement and leadership training and have shown appreciation for my experience, knowledge, time, and efforts in the form of financial compensation, class release time, and additional resources.

In addition, the growing focus on the importance of professional development and support for teachers has been of great benefit to me. Born out of concern and the need for academic achievement in math and science, Wesleyan University began the Project to Increase Mastery in Math and Science. The PIMMS project is a professional development resource funded by Federal grants which offers a series of summer fellowship programs for teachers.

I am also looking forward to participating in a professional development program sponsored by the AFT, Research and Dissemination Program, ER&D. This union-sponsored, research-based professional development program, Thinking Mathematics, currently offers three courses for elementary school teachers and will soon add a middle school component. Comparative studies in Scranton, PA and Tallahassee, FL have found that students of teachers who have taken Thinking Math outscore peers whose teachers have not.

Another wonderful professional development program being used in Hartford comes from the University of Pittsburgh's Learning Research and Development Center: Institute for Learning. The institute offers a 3-year instructional leadership program to develop leadership skills to help support higher achievement for diverse student populations.

I am currently finishing my 6th-year degree in educational leadership at the University of Connecticut. This certification will allow me to step into the position of Hartford District Middle School Math Coach so that I can reach all Hartford middle school math students by working with Hartford teachers one-on-one, modeling, supporting, and facilitating professional development workshops.

Like the City of Hartford, Hartford students are on the rise and I am and will continue to be part of that success.

But my success as a math teacher cannot be attributed to any one thing. The journey began with a love for math, but I could not have come as far as I did without the financial aid through grants and scholarships. Without the city's teachers who saw potential and challenged and motivated me, I would not be the person I am today. UConn was able to help me with the Bridge Program, which is supported through Federal grants and the university's money. Hartford's Board of Education provided time, resources, and financial compensation for increased involvement and professional development, also funded by grants as well as taxpayers' money. I have also been supported financially through Federal and State grants that fund programs like CPEP and the BEST program in Connecticut.

The PACE bill will help efforts to recruit qualified American science teachers into teaching, particularly in hard-to-staff schools like mine. In addition, the bill will afford current teachers the opportunity to obtain advanced degrees in their subject areas. While these are important steps, I believe more is needed, including assistance for other teachers once they are in the classroom, such as mentoring for new teachers, and support for teachers taking leadership roles is also needed.

We also need to look at the issue of school infrastructure. Even the most well-prepared teachers, for example, cannot provide the best possible opportunities for students to learn without adequate facilities. This is particularly true for math, science, and technology. Many of our public schools, particularly in urban areas like Hartford, lack the most basic physical resources, including up-to-date laboratories.

I urge you to take my experience into consideration. Where would students like me be without the help of Federal grants and the support of Federal, State, and local programs? I represent the interests of students all across America who want to succeed in math, science, and engineering. More importantly, I represent those students interested in math, science, and engineering who want to become teachers. Let us give them a way to get there.

Thank you.

Senator ALEXANDER. Thank you, Ms. Flanagan. In a hearing about teachers, it is nice to have a Teacher of the Year.

[The prepared statement of Ms. Flanagan follows:]

PREPARED STATEMENT OF DOLORES FLANAGAN

Good Morning, Chairman Alexander, Senator Dodd and members of the Subcommittee on Education and Early Childhood Development. My name is Dolores Flanagan and I am a middle school math teacher at Burr School, a public school in Hartford, Connecticut. I am also a member of the Hartford Federation of Teachers/AFT. It is an honor to be here to testify on what I believe is necessary to help prepare, train, and support our Nation's public school math and science teachers.

I have been teaching in Hartford for the past 7 years and see 125 students on a daily basis. The courses I teach include algebra, pre-algebra and preparation for the Connecticut Mastery Test, known as the CMT. I have met Connecticut's strict requirements to become a teacher and am considered highly qualified under the No Child Left Behind Act. I am proud to say that my students are meeting high standards in math and learning what they need to go on to higher-level math courses in high school. Becoming a highly qualified and successful teacher has been a rig-

orous and challenging journey, with many contributing key factors from the Federal, State and local levels.

I was born with a love for math. This affinity for numbers became a love affair when my 8th-grade algebra teacher, Mr. Fuentes, introduced me to the Connecticut Pre-Engineering Program (CPEP). This one-of-a-kind program in Connecticut was established to encourage students at a young age to aspire to careers in the fields of mathematics, science, engineering and technology. At the time, having recently moved from Puerto Rico, I was struggling with the English language but sought refuge in my success in the pre-engineering program. That year proved pivotal after I won first place in Connecticut's statewide Bridge Building Competition. I didn't know it at the time but my interest in math was broadening. The stage for inquiry was set and I began to develop interest in engineering as well as science. I went on to win first place in the Bridge Building Competition for a second consecutive year and became a finalist at Connecticut's Statewide Science Fair with a 3-year experiment, "The Effects of Plant Hormones on Plant Growth."

I knew at that point that I wanted to become an engineer and worked very hard to achieve my goal of getting into the University of Connecticut's (UConn) engineering program. There were, however, some challenges. Although I graduated as salutatorian of my class, English was my second language and my SAT scores were merely average. Nevertheless, I was awarded approximately $30,000 in scholarships from different agencies and foundations such as the Fox Scholar Foundation and the Society of Hispanic Women Engineers. UConn accepted me into its engineering program with one stipulation—my acceptance into the engineering program would only be considered upon my successful completion of its "Bridge" Program. Sponsored by the School of Engineering, in coordination with the Engineering Diversity Program, the Bridge Program provides a 6-week intensive study of mathematics, chemistry, physics and computers. The purpose of the summer program is "to prepare underrepresented students for the engineering curriculum at UConn, present an orientation to careers in engineering and to familiarize students with the University of Connecticut and the college experience" (www.engr.uconn.edu/edpweb/bridge/detail.html). It worked. I was part of UConn's School of Engineering for 3 years until I began to question my purpose in life.

I thought about how my 8th-grade teacher had challenged and inspired me to become involved and use my talents, ability and intelligence to take me to the highest levels. Mr. Fuentes was the catalyst in a long series of fortunate events. I wanted to have that kind of an effect on people, specifically children and young adults. I decided to apply to UConn's School of Education. I was admitted into UConn's IBM Program, a 5-year integrated bachelor's and master's degree program. Its mission is to prepare students for the real-world challenges of teaching through courses in curriculum development, assessment and instruction, opportunities for application of knowledge such as teaching internships in both rural and urban settings, seminars, workshops, tutoring and personal counseling. Two years later I graduated from the University of Connecticut with a master's degree in elementary education and a minor in math. I also gained a cross-endorsement in middle school mathematics.

My first teaching assignment began in August of 1999, in a title I, K–8 school in Hartford, Connecticut. Due to the teacher shortage in the areas of math and science and that fact that I would be teaching in a title I school, the Board of Education was able to start me at level 5 of our teachers' salary grid, when new teachers usually start at level 1. The compensation for my knowledge of math was a bonus and made the position of math teacher more attractive. Nevertheless, mentors were scarce, classrooms were overcrowded, and discipline and student achievement were areas of major concern. I thought about quitting every day for 3 months. It would definitely have been easier to go back to engineering where I would have made three times what I was making. Furthermore, I wouldn't have been responsible for 140 fragile teenagers who had bigger problems in their lives than worrying about math or passing the CMT. While not all engineers can be teachers, I knew that teaching was my talent and that this was not something I would walk away from. I needed help.

Thankfully, Mr. William Grupp, a veteran math teacher of 23 years, became my mentor. Having a mentor and a supportive administration allowed me to focus on what really mattered: developing my students' math skills, challenging and increasing their intelligence and motivating them to do their best. This support kept me in the classroom.

By my 3rd year of teaching, I had produced a teaching portfolio that was ranked third in Connecticut and was used for teacher training purposes. My students had the highest gain in the mathematics component of the CMT in the city of Hartford, and I was given the Teacher of the Year award. Since then, I have become part of

Hartford's Mathematics Curriculum Writing team, a Numeric Math Coach, a certified Math and Science Mentor, a member of the Hartford Mayor's Educational Task Force, an elected member of the Hartford Federation of Teachers Executive Board and a mathematics teacher portfolio scorer for Connecticut's BEST Program, the State's beginning teacher and educator support and training program. Hartford's Board of Education, the city of Hartford and the State of Connecticut realize the importance of teacher involvement and leadership training in the area of mathematics and have shown appreciation for my experience, knowledge, time and efforts in the form of financial compensation, class release time and additional resources.

In addition, the growing focus on the importance of professional development as an instructional tool and support for teachers has been of great benefit to me. Born out of concern and the need for academic achievement in math and science, Wesleyan University began the Project to Increase Mastery in Math and Science (PIMMS). The PIMMS project is a professional development resource funded by Federal grants, which offers a series of summer fellowship programs for teachers. These two-summer, multi-week institutes are designed not only to increase the participants' content knowledge but also to provide them with new strategies for teaching, including how best to use technology. The institutes also develop participants' leadership capabilities so they can share their experience and knowledge with their colleagues. The director of PIMMS, Mike Zebarth, stated that the record number of grants received allowed them to conduct summer workshops for 150 elementary and middle school teachers in Hartford, just in the past year. I have been one of those fortunate teachers.

I am also looking forward to participating in a professional development program sponsored by the American Federation of Teachers (AFT) Research and Dissemination Program (ER&D). This union-sponsored, research-based professional development program, *Thinking Mathematics*, currently offers three courses for elementary school teachers and will soon add a middle school component. It is based on research, consistent with the findings of the National Research Council's *Adding It Up* report, on how children learn mathematics. It also draws on lessons from international studies such as TIMSS. As the research on how children learn math is examined, teachers discuss the implications for their classrooms and increase their own mathematical knowledge. They learn why students make common errors and the core ideas of basic arithmetic that lay foundations for higher mathematics. Comparative studies in Scranton, Pennsylvania, and Tallahassee, Florida, have found that students of teachers who have taken Thinking Math outscore peers whose teachers have not.

Another wonderful professional development program being used in Hartford comes from the University of Pittsburgh's Learning Research and Development Center: Institute for Learning. The institute offers a 3-year instructional leadership program to develop leadership skills to help support higher achievement for diverse student populations.

I am currently finishing my 6-year degree in educational leadership at the University of Connecticut and have met all of Connecticut's requirements to be certified as an administrator. This certification will allow me to step into the position of Hartford district middle school math coach. The position will provide me with opportunities to reach all Hartford middle school math students by working with Hartford teachers one on one, modeling, supporting and facilitating professional development workshops. Like the city of Hartford, Hartford students are on the rise, and I am and will continue to be a part of that success.

My success as a math teacher cannot be attributed to any one thing. There have been many contributing factors in my journey as a math teacher. The journey began with a love for math, but I could not have come as far as I did without the financial aid and support of the city of Hartford, through grants and scholarships. Without those grants and scholarships I never could have gone to college. Without the city's teachers, who saw potential and challenged and motivated me, I would not be the person I am today. UConn was able to help me with the Bridge Program, which is supported through Federal grants and the university. Hartford's Board of Education provided time, resources and financial compensation for increased involvement and professional development also funded by grants as well as taxpayers' money. I have also been supported financially through Federal and State grants that fund programs like CPEP and the BEST program.

I urge you to take my experience into consideration. Where would students like me be without the help of Federal grants and the support of Federal, State and local programs? I represent the interests of students all across America who want to succeed in math, science and engineering. More importantly, I represent those students interested in math, science and engineering who want to become teachers. Let's give them a way to get there.

The PACE bill will help efforts to recruit qualified math and science teachers into teaching, particularly in hard-to-staff schools. In addition, the bill will afford current teachers the opportunity to obtain advanced degrees in their subject areas. While these are important steps, I believe more is needed, including assistance for other teachers once they are in the classroom, such as mentoring for new teachers and support for teachers taking leadership roles. We also need to look at the issue of school infrastructure. Even the most well prepared teachers, for example, cannot provide the best possible opportunities for students to learn without adequate facilities. This is particularly true for math, science and technology. Many of our public schools, particularly in urban areas, lack the most basic physical resources, including up-to-date laboratories.

Thank you again for giving me the opportunity to share my experiences with you. I am very proud of the work I do and the success of my students. If you are ever in the Hartford area, I encourage you to come see our school in person.

Senator ALEXANDER. Senator Bingaman.

Senator BINGAMAN. Thank you very much, Mr. Chairman, for organizing this hearing and your commitment on this set of issues. It has been outstanding to watch the progress you have been able to make and it has been a pleasure to work with you on that.

Let me ask, first, Secretary Garcia, I first commend you for the national recognition that you have achieved and New Mexico has achieved for the challenging academic standards that we have adopted and the rigorous teacher licensure requirements that we have adopted in New Mexico. I think that is very commendable.

You say in your statement that we have done some things just recently, and I gather that is in the recently completed legislative session there in Santa Fe, to create a Math and Science Bureau within the Public Education Department, also to make a significant investment for teacher professional development in math and science summer institutes. You also indicated significant increases in the area of Advanced Placement programs. Could you just elaborate a little on any of those that you would like to?

Ms. GARCIA. Thank you, yes. Mr. Chairman, members of the committee, Senator Bingaman, we have passed a Math and Science Act. The legislature passed that this last session. With that will be $3 million that we will be partnering with the universities and also the labs to provide professional development in the area of math and science in terms of summer institutes to better prepare our teachers to teach to these rigorous standards and also use some of the latest pedagogy and infusing technology in their instructional technique.

We also created a Math and Science Bureau within the Department. This is a result of the math and science town hall that we had in our State. That was one of the recommendations, that we elevate that in our agency to provide more professional development opportunities and technical assistance in a number of areas, whether they are aligning textbooks to the standards, etc., in our State, and we will have a bureau chief specifically for this area.

And then the third thing—I forgot what you had asked me about.

Senator BINGAMAN. The Advanced Placement.

Ms. GARCIA. Advanced Placement. We were not as—we had a recommendation for $2 million. Unfortunately, we were only funded for about $700,000. I want to be able to package this again next year and really push, because we find that Advanced Placement not only helps the students, it is a tremendous professional development tool for the teachers and it improves all the courses that

they teach, and what we have found is that they also help their colleagues and their school improve their teaching pedagogy. So again, I want to thank you for your efforts in helping support Advanced Placement, but we still have a ways to go in our State.

Senator BINGAMAN. Mr. Chairman, let me just make—thank you very much for the answers. Let me just make a general observation. I think we have made some good progress in getting math and science education on the national agenda. The President has done that with his statements in the State of the Union Speech.

I guess one concern I have got is that there doesn't seem to be, at least so far, the commitment of resources that is going to be needed to make any significant change in the way we are going at this. I think all of these witnesses are reporting on progress that they are involved in and they were sort of chosen because of progress they are involved in. But when you talk about the great breadth and width of this country, we have got an awful lot of teachers out there who are not going to have resources expended on their development the way we are now going forward.

I don't know if that is a fair criticism, but I hear the story from the University of Texas, the University of Pennsylvania. Those are very good stories, very good initiatives. I just look in our own State. We have most of our teachers coming out of our universities are not going to those universities. They are coming out of universities that are not equipped currently to provide that kind of instruction in math and science, and I am wondering if we can take the models that are there at those schools and slim them down to something we could actually get replicated in our schools, in our universities which are turning out the vast numbers of teachers that are coming out. That is the concern I have. I don't know if either of the witnesses would want to comment on that, but I would be interested in their views.

Ms. RANKIN. I think scale-up is always a challenge, but I do think UTeach could be replicated. I think one of the big things that we did was to incorporate experienced excellent math and science teachers as part of the faculty. That was critically important and it really informs the program. The other thing that was really important was to incorporate field experiences and recruitment of math and science majors by getting them to try out teaching. We give two 1-hour courses at the very beginning of the program that just focus on how you teach. The Master Teachers that we employ train the students to go out and give science lessons in pairs four times for the first semester in elementary school and then in middle school and it captures them and gets them into it.

I think you can do this at Research I universities like the University of Texas across the country and really ramp up the program, but at smaller places where you have challenges with actually the students getting mastery of the math and science, I think there, you need to focus, along with these other elements, on enriching the math and science curriculum, and I think there are ways to do that.

In fact, Treisman has some great theory about this that we have implemented at UT-Austin that works extremely well, giving, I guess, immersion and enrichment in math and science curriculum with a lot of mentoring and a lot of practical applied problems so

that they really see the relevance of the math or whatever to real life. It seems to—we have a major program in our college for kids coming in with poor backgrounds in math and science. It has been very effective.

So I think it can be ramped up, but I think you have to focus on the best practice and really try to incorporate it.

Mr. DAI. Senator Bingaman, I think you really hit on a very important question. Just like Secretary Garcia noted, how to involve the institutions of higher education in this effort is a very important one. I actually think that there is a widespread recognition by faculties in these institutions of higher education that there is a crisis in science education at present in this country and people actually are eager to contribute.

I will speak from my own experience. We actually have schools like Columbia University, the University of Maryland, Boston University, and also the University of St. Louis in Missouri. They all came to us and they wanted to replicate the program. But the issue is that there has to be some financial support, because this is an added function to the existing research and teaching missions of these universities. So this is where the PACE Act can assist.

Senator BINGAMAN. Thank you very much.

Senator ALEXANDER. Dr. Garcia.

Ms. GARCIA. Yes, thank you, Mr. Chairman, Senator Bingaman, members of the committee. Just very quickly, the Teach for America program has been a real wonderful infusion of motivated, excited teachers that have helped us in a lot of our Native American communities, and perhaps with that existing program, that they could try to recruit more math and science majors, because it appears that the training that they get in their summer prep program before they go out into the schools seems to be very strong and we seem to be getting good results from those classrooms.

Senator ALEXANDER. Thank you. I want to acknowledge that Senator Bingaman is the principal Democratic cosponsor of the PACE Act and joined in the letter to the National Academy of Sciences asking for it and has been the principal advocate, along with Senator Hutchison, I guess, on the Republican side of Advanced Placement courses in the Senate.

Dr. Vagelos, can you summarize briefly the process that the Augustine Committee used to identify these 20 recommendations you have made to us? Basically, our question to you in the report was, tell us exactly what we need to do as Federal policymakers to keep our advantage in science and technology over the next 10 years.

Mr. VAGELOS. Right.

Senator ALEXANDER. "The Gathering Storm" report was the answer to our question. How did you come up with those things and how many things were there?

Mr. VAGELOS. That is interesting. You mentioned that there were 21 people who were invited to the committee. Twenty people put down what they were doing for the entire summer, 10 weeks, actually, to start reviewing all literature, and we started by pulling together information from about 40 experts in the field, all the fields that we were to cover, that is, K through 12 education, which was identified by the committee as the number one priority to keep us

competitive internationally, higher education, research, and policies.

So we brought together experts in each of those four fields and we distributed questionnaires in advance as to what they thought were the important things to go forward. We circulated tons of information of studies that had been done in the past with recommendations. So we worked through that through the summer and then we had one major meeting in Washington several days where we talked with each other and we heard all the experts, pooled that material, and then we met as a committee on really phone meetings to come up with our recommendations.

Then we said, what are the most important things that we can do, and as I said earlier, K through 12 was the number one priority and each of those is in priority order. But doing K through 12 was not enough. We then had scholarships for science and math and engineering and technology at the universities, scholarships for that, fellowships to follow, and once these people were to finish, they had to have places to work, so we recommended a sharp increase in research funding and equipping the laboratories, re-equipping the laboratories that were out there and had often been built 25 years ago, were not up to date and competitive with our international colleagues.

And finally, focusing on policies also that would support the whole system. So it was a very tedious and vigorous process that was done with enormous effort of these 20 people who responded. The hope is that the whole package would go as is, that is, all of the K through 12—as I mentioned, both the shorter-term that affect many people, the large numbers of current teachers, and frankly, the summer institutes would cover 250,000. So they are large numbers.

And each of these programs, which I think are the core of bringing up—getting the teachers who have a fundamental understanding of the content in both the undergraduate program of the UTeach—by the way, that has been just picked up by California, as you know, and they are going to be putting out 1,000 of these per year, so the replication is catching on quickly.

The Master's program, these are smaller by necessity because people have to learn to do them, and they will produce perhaps 10,000 students per year, and it is a long time before you impact the total teaching. I think Tom Luce used the number 235,000 teachers out there in math and science, not counting the lower grades.

So the program is inclusive——

Senator ALEXANDER. Before my time expires, let me ask one quick question for Dr. Rankin——

Mr. VAGELOS. Yes.

Senator ALEXANDER. If you need to wrap up, go ahead.

Mr. VAGELOS. I essentially think that the proposal is great and we wish you luck.

Senator ALEXANDER. Thanks. Dr. Rankin, would the UTeach program include community colleges?

Ms. RANKIN. I think it could. I think you could——

Senator ALEXANDER. What would be the pros and cons?

Ms. RANKIN. Well, I think the challenge would be the math and science training side of it, and you would have to figure a way into the program. In my written testimony, I have put a description of the program I just referred to that we have used at the University of Texas for at-risk students. I think you could build that in, but one of the things that makes UTeach so successful is that we are drawing on students that have a strong background in math and science. The community colleges, I would say, are a mixture of those that can and would be challenged to deliver that level of instruction, and the student population would be a mixture, too. So you would have to find ways, and ours might be one, to enrich that and bring them up to speed.

You know, I think it is important not to be discouraged by the fact that these teacher preparation programs like UTeach can't train massive numbers right away. These people can seed the school that they enter and really change the thinking and the focus of individual schools, as well, that we are training teacher leaders here and the Master's programs do the same thing, and these people can have a multiplier effect within their own schools, as well.

So I think we just need to start and do what we can at all different levels.

Senator ALEXANDER. Thank you.

Senator Isakson.

Senator ISAKSON. Thank you, Mr. Chairman. I want to commend Dr. Rankin. You all have broken the code. For years, I was so frustrated with colleges of education in the State of Georgia for being so distant from the public schools that they were training teachers to teach in an environment they were totally unprepared to go into, and I want to call everybody's attention—I don't know what page it is, but Dr. Rankin couldn't get to it in her oral statement—they hire nontenured former high school math and science teachers to come teach at the Department of Natural Science so they can expose these future teachers to what the real world is like.

Unfortunately, most of America's colleges of education think that Ozzie and Harriet and Wally and the Beaver are the typical American family, but they aren't anymore. These teachers are going into schools that are totally different and very diverse and very challenged, and I really commend you on that. I think that has got to be part of the secret to your program.

Second, how in the world did you convince the UT Department of Education to let the Department of Natural Sciences give degrees in education? How did you break that away from them?

Ms. RANKIN. Well, this was a big deal at the beginning, but education has been a great partner with us, actually. But Texas is one of, I think, something like 33 States where there is a State law that mandates that people who teach, at that time in high school, had to have a degree in their discipline. So, in fact, it was our responsibility. Although education was providing the actual certification tests, we were supposed to have a teacher preparation program that trained these students and we just hadn't. I mean, the law was enacted in the early 1980s, but we didn't really start doing anything serious about it, creating a specific successful program until much later.

So I think actually that law is important in getting math and science, or colleges of arts and science, whatever, involved in this process. Where that doesn't exist, most of this training still happens in colleges of education, some of which are wonderful, but some of which are not.

Senator ISAKSON. And one of the testimonies of this program, Mr. Chairman, I think it says in your testimony that over 80 percent of the UTeach teachers who went in the classroom in 2001 are still teaching.

Ms. RANKIN. That is right.

Senator ISAKSON. Well, that is the reverse of the national average. Eighty percent have usually quit after 3 years, and I would say it is because of what you have done in that structure.

Second, your Texas interdisciplinary plan, and I was reading fast to get to that——

Ms. RANKIN. Yes.

Senator ISAKSON. [Continuing]. But I commend you on that because there, you are saving souls that a lot of times are cast aside when they really are redeemable that are coming to the university. Are many of those coming into the UTeach program after they graduate from school?

Ms. RANKIN. Some do. Some do, yes. In fact, it is simultaneous. They can enter both programs at the same time, and many of the UTeach courses actually include TIP students anyway, because we try to have small classroom experiences whenever we can for the UTeach students, as well.

Senator ISAKSON. In a way, Ms. Flanagan is almost an example, because I think in your testimony you talk about because of your language difficulties, you didn't score necessarily that well on the SATs, but you were highly inclined toward engineering and math and science, and because of your mentors, Mr. Fuentes and the other gentlemen that you mentioned, she made it.

Ms. RANKIN. Absolutely. I thought of that when she was speaking.

Senator ISAKSON. Yes.

Ms. RANKIN. I thought, she could have been in one of our programs. It was a great example.

Senator ISAKSON. What they are doing with this TIP program is they take these kids who you would statistically identify as an underachiever or not ready for prime time or whatever you want to call it and they put them in the study skills and critical thinking classes early on to get them to develop, and then they come out highly competitive students, graduating under UTeach and other disciplines in the university. And she didn't pay me to say this or anything——

Ms. RANKIN. I really appreciate you bringing this up.

Senator ISAKSON. You really have broken the code in what you all are doing there, because higher education, which I am a big fan of, I sometimes don't sound like it, but for years, I used to say they ought to make tenured teachers of education teach in the public schools once every 5 years and that would cure our educational problems. You can't make them do that, but you certainly can take what you are doing and do a remarkable exposure of those students

so that when they go to the classroom, they are ready. So I commend you on what you are doing.

Ms. RANKIN. Thank you, Senator. I appreciate it.

Senator ISAKSON. Thank you, Mr. Chairman.

Senator ALEXANDER. Senator Ensign.

Senator ENSIGN. Thank you, Mr. Chairman. I want to take a little different look, because I think that a lot of us have the same goals, but we have to keep in mind our past experiences up here and remember the law of unintended consequences. We have got a lot of momentum now going forward on the whole issue of competitiveness and bringing that to our schools. Dr. Dai, you talked about the 70 hours of subject matter classes that Taiwan requires in each discipline a teacher teaches. Dr. Rankin, what is the requirement for UTeach—what is the number of hours required in their core subject?

Ms. RANKIN. I can't tell you that. I am dean of the college and I can't tell you. It is different for all the different majors. They basically do a regular math or science major——

Senator ENSIGN. OK.

Ms. RANKIN. [Continuing]. With not much compromise, actually, and then they interlace the pedagogy courses with them. The interesting thing that we have seen is that because the pedagogy courses are really focused on how you teach math and science and they are all mixed in——

Senator ENSIGN. Right.

Ms. RANKIN. [Continuing]. These kids are teaching what they are learning, and so that reinforces it. It has been great.

Senator ALEXANDER. I think that you are absolutely on the absolute right track. I agree with Senator Isakson. I have had many talks with our university presidents about this particular issue. Everybody has had these conversations across the country because we see so many of our kids not learning, not being motivated to go into science and math, and frankly, the teachers are not nearly as skilled because of this separation. Because of the idea that you have to get a teaching degree from the college of education, we ended up with people who are not skilled in their level.

The question I had for maybe both Dr. Dai and Dr. Rankin is that: let us say I have an engineering degree, or I have a physics degree, or I have a math degree, do you have anything within that type of a program that then can take that person, and accelerate teaching, so that they can get a teaching certificate? Because most of them still have to go through the departments of education in most States where they may learn how to teach, but not necessarily how to teach math and science again.

Ms. RANKIN. We do have a postbaccalaureate entry. Actually, one of the things I want to do is——

Senator ENSIGN. And how long does that take?

Ms. RANKIN. It takes a year, and one of the things I want to do—in fact, if funding could support a person doing that, that would be a very good thing. But I would also like to shorten that with UTeach. That is one of the things that we are going to focus on in the next sort of go-around.

Senator ENSIGN. Because I think that we have got a lot of people out there right now that maybe have had a 20-year or 30-year ca-

reer. You had help at the beginning of your career, Ms. Flanagan, but maybe somebody else wants to do it 20 or 30 years from now as a second career. Maybe they say, I would really like to teach, but I don't want to go through a 4-year program——

Ms. RANKIN. Absolutely.

Senator ENSIGN. I have subject matter knowledge and skills. I need to be taught how to teach, but I don't want to go through a long program. I know some of you want to respond, but I just want to get this other point out, and that is because in looking at the recommendations that have come out about, for example providing $20,000 per year, we must first look at unintended consequences.

Let us say, for instance, you gave these $20,000 scholarships to students. In the State of Nevada, it is $3,000 per year, on average, for in-State tuition. Do we perversely incentivize other States that have lower tuition costs to look and determine that they could get a lot more money if they raised their tuition because the Federal Government will foot the bill. We know that the cost of higher education is outstripping inflation or almost any other measurement in our economy, other than maybe health care. The costs of higher education have skyrocketed and the justification seems difficult to find. Would we perversely incentivize some of the colleges like the University of Nevada to increase tuition by providing these scholarships? Would that, in turn, lead to other students not being able to afford the school, and so then we would have to increase Pell Grants and on and on and on. Would you like to comment on that, Dr. Vagelos?

Mr. VAGELOS. Well, of course, there are enormous differences between the State universities and private universities——

Senator ENSIGN. Absolutely.

Mr. VAGELOS. [Continuing]. In tuitions, and so the decision was made to make up to $20,000. Will that incentivize the lower-cost tuition universities to raise them? Well, it could. It could. The idea is, of course, to keep the tuitions to the lowest possible number so that we will not lose students who cannot even reach those numbers. But it is a possibility.

Senator ENSIGN. You see that. I just wanted to raise it, because I think that it is a possibility, and we should look at all possibilities whenever we are looking at new programs.

Mr. VAGELOS. Even now, the annual tuition in the State universities is outstripping inflation and they are no longer small numbers. They are large numbers that are excluding some students.

Senator ENSIGN. Does somebody else want to comment? My time is up, but if they have——

Senator ALEXANDER. Go ahead if you have any other questions——

Senator ENSIGN. I don't have any other questions, but they have their hands up like they wanted to respond to something else I said, so if either one of you——

Senator ALEXANDER. Please do.

Ms. GARCIA. Thank you, Senators, Mr. Chairman, Senator Ensign. I just wanted to comment on alternative licensure. New Mexico does have alternative licensure for those who have degrees in a content area. It is 12 hours, and they take 12 hours of pedagogy while they are actually in the classroom. However, I am not certain

that the pedagogy is the best methodologies for math and science and so I think that if there could be funds to help incentivize those programs for our universities, that would be terrific.

Senator ENSIGN. OK. On the funding of these programs—looking at perverse incentives—I think one of the things we also have to look at is where programs are already funded like the University of Texas. We have a lot of programs out there. Do we just need to reprogram the programs or do we need to start new programs? I think that is a big question we need to ask up here as we are going forward. We do have limited dollars, and to maximize those dollars, we have to look at those kinds of questions.

Ms. FLANAGAN. Connecticut has a program called the ARC program and it is for noneducation professionals who have a Master's degree and would like to change their careers, and this is a 6-week intensive summer program. They meet from eight in the morning to 5 o'clock in working groups and are given curriculum instruction, development, assessment, all the pedagogy that they need, and then they go——

Senator ENSIGN. Are they doing it in what they talk about, though, in how to teach math and science?

Ms. FLANAGAN. Yes, correct.

Senator ENSIGN. And not just how to teach?

Ms. FLANAGAN. How to teach math and science. English is also a component, so it is English, math, and science, and they go into a 2-year program where they have mentors and, you know, whatever city they go into, the city does support these people.

Senator ALEXANDER. Thank you. Thank you, Senator Ensign, and thanks to all. I just have one question I would like to ask. Senator Ensign, do you have any other questions that you would like to pose?

Senator ENSIGN. No, and I have to get over to the Capitol, unfortunately. Thank you once again, and I wish we had more time. This is such a fascinating subject and we look forward to the hearings tomorrow, as well.

[The prepared statement of Senator Ensign follows:]

PREPARED STATEMENT OF SENATOR ENSIGN

First I would like to thank Senator Alexander for holding a hearing on this important issue. He and I share the common goal of bringing competitiveness and innovation back to the forefront of America's education system. Numerous reports have been issued lately that emphasize the importance of math and science education for our students and training and professional development for our teachers as key to the future of our Nation. The United States has been leading the world in both competitiveness and innovation for some time, but we are quickly losing our advantage.

The purpose of this hearing is to review legislation that is designed to keep the United States at the forefront of competitiveness and innovation, especially in science, technology, engineering and math. Senator Alexander has introduced the "Protecting America's Competitive Edge" Act, commonly known as the PACE Act. This legislation represents a broad, and expensive, expansion of Federal programs targeted at improving math and science education and increasing the number of math and science teachers in this coun-

try. I have introduced, along with Senator Lieberman, the National Innovation Act. This legislation is based on the findings of the Council on Competitiveness and their National Innovation Initiative.

I would like to address some of the key questions that were presented for this hearing.

• What are the proposals of S. 2198? Where did they come from? Why were they proposed?

The National Academies of Sciences (NAS) was asked by Senator Alexander and Senator Bingaman to respond to certain questions related to science and technology and how the United States can "successfully compete, prosper, and be secure in the global community . . ." The committee assembled by the NAS was given only 10 weeks to come up with their recommendations. To my knowledge, many of their recommendations were made without review of current Federal programs or initiatives. It would be my hope that we could review existing Federal programs to determine if they are meeting a national need and if they are meeting their stated goals and objectives. We must also ensure that any program, whether old or new, has effective metrics in place to measure achievement and effectiveness.

I must commend the NAS study for the recommendation they had of reallocating existing Federal funds to meet new and emerging needs. I was shocked that the Federal Government currently funds over 207 math and science related programs. This shotgun approach only scatters precious Federal resources across the country with little accountability for their usage or effectiveness. I would propose using a rifle approach that carefully allocates resources to our greatest areas of weakness and uses programs and approaches that have proven records of effectiveness. It is clear based upon the testimony of today's witnesses that there are proven programs in the field; we must now link Federal funding sources with those effective programs.

• What are the administration's views? Are there other proposals that should be considered?

President Bush has come out with a very strong proposal with his American Competitiveness Initiative. This proposal focuses resources on proven programs that best help our students and teachers. As I mentioned before, I have introduced legislation with Senator Lieberman, the National Innovation Act, that builds off of current Federal programs. However, this legislation does not address the teacher shortage issue in the areas of math and science.

• What existing Federal programs can be re-shaped to focus on this effort?

According to the Congressional Research Service, the Federal Government currently spends approximately $4.1 billion every year to support a broad array of teacher recruitment and retention programs. These programs range from supporting alternative routes to teacher certification to loan forgiveness for teachers to traditional teacher recruitment activities. While I certainly understand the need to attract individuals to the profession of teaching overall, it is apparent that more needs to be done to attract individuals into teaching math and science. In Clark County we face a teacher

shortage every year, but the shortage is felt the most in the subjects of math and science.

I am interested in learning more about what the Federal Government can do to better tailor some of these programs to attract students into the fields of math and science. How can the Federal Government work with programs that are in existence, like UTeach?

Every one of us here today needs to take a close and very critical look at the report issued by the Government Accountability Office on the $2.8 billion that is spent on 207 math and science related programs. Congress needs to take a very close look at where the Nation's priorities lie when determining which of these programs receives Federal funding. We need to look at the National Academy of Sciences report and the National Innovation Initiative for ways to improve our focus and fund proven and effective programs.

- How could S. 2198 be improved?

I believe this legislation could be improved by taking the concepts presented in PACE and embedding them in existing Federal programs. We must try this first before creating a myriad of new Federal programs. In addition, we must find ways to pay for these new programs. I would recommend looking at the education programs we already have, especially those noted in the GAO report, and determining which programs are effective at meeting their goals and which are not. We also need to look at what programs have met their original purpose and are obsolete. Finally, we need to ensure that every program funded by the Federal Government includes metrics so we can measure effectiveness and hold them accountable.

If the United States is going to maintain its' competitive edge and remain the world's super power then we need to take these reports seriously. We must look at this issue as not only an education issue, but as a tax issue and a commerce issue. We need to look at what the Government is doing to both hinder and help innovation and competitiveness inside and outside of the Government. In my opinion we cannot simply throw money at this problem. We must take time and ensure that these programs are given metrics and that their effectiveness is proven before investing in them.

I applaud the work that Senators Alexander and Bingaman have done with their PACE Act and look forward to working with them. Together I hope we can find the best and most workable solution for getting more math and science teachers into the classroom so we can better help our students achieve great results.

Senator ALEXANDER. Good. Thank you for so much of your time today.

Dr. Garcia, one of the PACE recommendations is to provide assistance to national laboratories as well as colleges and universities to host 1- or 2-week seminars for up to 50,000 math and science teachers for hands-on training in professional development. So my question is, since you have two national laboratories in your State, do you think it is a good idea to center some of the summer institutes for math and science teachers at national laboratories? What would be the strengths of that idea, or weaknesses?

Ms. GARCIA. Mr. Chairman, I think that our history in New Mexico in partnering with the labs in education has been very success-

ful. The one that we have with the Los Alamos National Laboratory and the Math-Science Academy in Northern New Mexico, those teachers that have been in that program are getting better results with students that traditionally have not performed well in math and science. So I would say that our experiences with both Sandia National Laboratory and the Los Alamos National Laboratories would indicate that this would be a good strategy.

Senator ALEXANDER. I want to thank each of you for coming. I want to close the hearing by reading something I mentioned at the beginning, because this really struck me, and we have had a lot of Texas here today, but I think it is important while we are talking about how far we have to go to show that there are plenty of examples around today that show that we can certainly get there if we apply the right brainpower to the task.

According to one of Dr. Rankin's scholars, Mr. Treisman, in 1999, 13 States participated as countries in a re-administration of the Eighth Grade Third International Math and Science Study. Now, this is probably the best known international study of math and science, if I am not mistaken. It is the one that I see most often cited. It is well regarded and countries compare their 8th graders in math and science.

Some States, like Texas and Michigan, scored at very high levels. Texas, whose sample contained more than 50 percent African-American and Hispanic students, performed at a significantly higher level than most European countries. Now, that has come after 15 years, at least, of effort in Texas. But that is a very important statistic to me, that in our second-largest State, where more than half of the students are Hispanic or African-American, on 8th grade comparisons in math and science, those students do better than 8th grade students in most European countries.

So we have a long way to go in many parts of the United States, but we do have clear evidence that we can get where we want to go.

I want to thank each of you for your time. Some of you have come a long way to be here. I want to invite you, if within the next week you have any specific recommendations on the PACE legislation or the comments on math and science teaching you would like for us to make part of the record, if you could get it to us, we would be glad to include it in the record.

Thank you. We will begin tomorrow's hearing at 10:00 a.m. on the remainder of the PACE K through 12 proposals. The hearing is adjourned.

[Additional material follows.]

ADDITIONAL MATERIAL

RESPONSE TO QUESTIONS OF SENATOR ENZI

RESPONSES BY TOM LUCE

Question 1. As part of the President's American Competitiveness Initiative, an Adjunct Teacher Corps has been proposed to encourage math and science professionals to become adjunct high school teachers. How would this proposal be aligned with the requirements for highly qualified teachers under No Child Left Behind?

Answer 1. This initiative will be consistent with the principles of NCLB's highly qualified teacher requirement—teachers must know the subject they teach. This new initiative would create an Adjunct Teacher Corps that would draw on the skills of well-qualified individuals outside the public education system to meet specialized teaching needs in secondary schools. The initiative would concentrate on helping schools find experienced professionals who would be able to provide real-world applications for some abstract mathematical concepts being taught in the classroom and, in some cases, provide individuals to teach temporarily in hard-to-fill positions.

Funds would be used to make competitive grants to partnerships of school districts and States (or of school districts and appropriate public or private institutions) to create opportunities for professionals with subject-matter expertise to teach secondary-school courses in core academic subjects, particularly in mathematics and science. Adjunct teachers might teach one or more courses on the school site on a part-time basis, teach full-time in secondary schools while on leave from their jobs, or teach courses that would be available online or through other distance learning arrangements.

Question 2. Training an additional 70,000 advanced placement/international baccalaureate teachers over 5 years is one part of the President's American Competitiveness Initiative. How will concentrating on AP/IB teachers improve science and math education for all students at every level of the K–12 education system?

Answer 2. The program helps teachers receive the training needed to teach Advanced Placement (AP) and International Baccalaureate (IB) math, science, and critical language courses. Program funds also support competitive grants to State educational agencies to pay AP and IB test fees, as well as State and local efforts to make pre-advanced placement and advanced placement courses more widely available to all students. AP and IB programs increase the rigor of high school curricula and offer a proven avenue to postsecondary success.

Also, our proposed Math Now for Elementary School Students and Math Now for Middle School Students programs will help to strengthen math instruction in the early grades and middle school, better preparing students for AP and IB programs in high school.

RESPONSE BY HAI-LUNG DAI

Question. How many middle school teachers and high school teachers have participated in your program? Are you aware of any programs similar to the Science Teachers Institute that provide opportunities for elementary teachers?

Answer. The Master of Chemistry Education program designed for training inservice high school science teachers was inaugurated in 2000. Up to now, more than 120 teachers, in 6 cohorts, have enrolled in this program. The fifth Cohort will graduate after this summer. The graduation rate of the teachers from this 10-course, 26-month program is about 85 percent. Of the 120 teachers who were all teaching or assigned to teach chemistry at the time of their enrollment, approximately three quarters did not have chemistry as either major or minor in their college studies. About 40 percent of the teachers were from urban schools/districts and 60 percent from suburban schools/districts. Teacher attendants were mainly from the four State areas of Pennsylvania, New Jersey, Delaware and Maryland, some as far as central Pennsylvania and northern Jersey and one from the State of Oregon. Many of the graduates from this program have been designated as master teachers or teacher leaders in their schools.

The Master of Integrated Science Education program designed for training inservice middle school science teachers took in the first cohort of 24 teachers in 2005.

The two programs will take in another 40 teachers in the 2006 cohorts.

The funding of the Institute at present will support teacher enrollment till 2009. By that time it is expected that these programs will have graduated altogether 270 teachers—170 high school science teachers and 90 middle school science teachers, directly impacting on the education of more than 30,000 high and middle school students annually.

As far as we know, there is no master degree programs with content knowledge focus for elementary school teachers. The middle school teacher program can in principle be modified for such needs.

RESPONSES BY ROY VAGELOS

Question 1. How many principals have participated in the MISE program during the past year and how do you measure its effectiveness?

Answer 1. Principals are responsible for managing and supporting school-based instructional programs; they have an integral role in the quality of teaching and learning taking place in mathematics and science classrooms in their school. Principal attitudes towards, and ability to support, mathematics and science teaching and learning can be important factors in the development of quality mathematics and science instructional programs. One of the goals of the Merck Institute for Science Education (MISE) is to develop principals into effective managers and supporters of mathematics and science education in their schools. This goal is to be accomplished through fostering of leadership structures and relationships, and development of the capacity of principals through Administrator Institutes and other professional development opportunities. Over the past year, MISE has worked with approximately 125 school administrators.

Data sources for assessing MISE's progress in leadership development come from principal and teacher surveys and interviews; observations of professional development activities; and principals' evaluations of their professional development.

Our principals were offered two professional development opportunities related to mathematics and science instruction. The Lenses on Learning program is a series of workshops with a focus on educating principals to recognize critical thinking among students around mathematics. Our Administrators' Institute was a workshop focused on building a shared view of quality mathematics and science instruction, and included activities on interpreting and using student achievement data in mathematics and science.

The Lenses on Learning Program

During the past year, a group of 25 elementary and middle school principals met regularly to participate in a professional development program developed by the Education Development Center. Using *Lenses on Learning* materials, principals viewed and discussed videotapes of mathematics classes, focusing their attention on the mathematical content of the lessons and students' mathematical thinking. External evaluators observed a number of the sessions and interviewed a subset of the principals to shed light on the program's impacts.

Quantitative data on the impacts of this program also have been collected in collaboration with researchers at the Education Development Center. In the fall we recruited 65 principals who took a Leadership Content Knowledge (LCK) survey. This survey gathers information on principals' professional background and measures the nature of principals' beliefs about how children learn mathematics and how it should be taught. In addition, the survey measures the depth of mathematics content knowledge. Subsequently, we randomly assigned 25 of these principals to an intervention group. These principals were offered the *Lenses on Learning* course during the school year. The remaining 40 principals were assigned to a control group and received no intervention. At the end of the school year principals in both the intervention and control groups took the LCK survey again.

We also conducted a study to obtain an indirect measure of change in principals' instructional leadership. This involved administering a survey to a sample of teachers in the fall and again in the spring. The sample contained teachers from schools led by principals in the intervention group as well as the control group. This survey was designed to capture teachers' perceptions of their principals' attitudes and practice of classroom observation and teacher supervision as related to mathematics instruction.

The data from the principal and teacher surveys are currently being analyzed and should be available within the next 6–8 weeks.

Administrators' Institute

This past year MISE once again sponsored an Administrators' Institute which was attended by nearly 100 principals and vice principals. Administrators participated in sessions designed to help them understand the vision for quality mathematics and science instruction; learn how to utilize data more effectively to make instructional decisions at the school level; and engage in planning based on information discussed at the Institute. External evaluators observed the sessions and provided feedback on their effectiveness. In addition, interviews were conducted with a subset

of the participants 2 months later to note the value of the Institute to their role as school leader.

Principals' Attitudes and Beliefs

The purpose of the professional development for principals is to help them support effective mathematics and science instruction in their schools. Annually, a questionnaire has been administered to principals to probe their attitudes and beliefs about mathematic and science teaching, and their preparedness to support teachers in these content areas. Analysis of the questionnaires indicates that the principals' attitudes and beliefs are becoming increasingly aligned with the vision of standards-based mathematics and science teaching.

Question 2. What has MISE done to encourage other similar organizations to provide these types of experiences for principals?

Answer 2. The Merck Institute for Science Education has actively disseminated information on its activities with principals using print materials and its Web site, and through presentations to national, State and local educator organizations. In addition, MISE staff has provided technical assistance in establishing programs to other, similar organizations.

RESPONSE TO QUESTIONS OF SENATOR JEFFORDS BY TOM LUCE

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 Department's 2007 budget includes $380 million in new funding as part of the President's American Competitiveness Initiative, which focuses on improving the Nation's long-term economic competitiveness through new and renewed proposals to fund and promote science and math education, basic research, workforce development, and immigration policies.

Specifically, the request includes:

• *$125 million for the Math Now for Elementary School Students* initiative, modeled after Reading First, to implement proven practices in math instruction—including those recommended by the National Math Panel—that focus on preparing K–7 students for more rigorous mathematics courses in middle and high school.

• *$125 million for a new Math Now for Middle School Students* initiative, based on the principles of the Striving Readers program, to support research-based math interventions in middle schools.

• *$10 million for a National Mathematics Panel*, which will be formed in fiscal year 2006, to identify key mathematics content and instructional principles to guide the implementation of the Math Now programs. The request for 2007 would be used to carry out the panel's recommendations, including research on and dissemination of promising practices in mathematics education.

• *$5 million for Evaluation of Mathematics and Science Programs* to conduct activities to improve the quality of evaluations of Federal elementary and secondary mathematics and science programs, as well as to evaluate such programs, with a focus on examining whether they are consistent with the principles of NCLB.

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 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 2. While it may be the case that the U.S. sets up math and science curriculum different than many other countries, the reality is that American students fall further behind many other countries as they move from 4th grade through 12th grade. On the most recent Program for International Student Assessment (PISA), American 15-year-olds performed well below the international average in mathematics literacy and problem solving. In addition, U.S. 12th graders perform well below the international average on the Trends in International Mathematics and Science Study (TIMSS) math and science general knowledge assessments.

In fact, according to the National Center for Education Statistics, the topics that were included in the 12th grade TIMSS are typically covered in much lower grades—i.e., math assessment topics are typically covered in about the 7th grade

and the science assessment topics are typically covered in about the 9th grade on average for the participating countries.

The fact that U.S. students perform poorly on international assessments such as the PISA and TIMSS points to the need for increased rigor in our schools' math and science courses if students are to be prepared for work in the 21st century. Students need to be introduced to pre-algebraic concepts in elementary school so that they will be prepared to take and pass algebra I by the 8th grade. Supporting schools in this effort is the goal of the newly proposed Math Now programs. And, more students should have access to and be encouraged to take advanced math and science courses in high school. That is why the Department's fiscal year 2007 budget request includes a $90 million increase to support an expansion of Advanced Placement programs in our Nation's high schools.

QUESTIONS OF SENATOR ENZI TO THE SECOND PANEL

QUESTION FOR DOLORES FLANAGAN

Question. Please give us a few examples of professional development experiences that have been especially meaningful for you and that increased the achievement of your students. What are three factors that these experiences had in common which made them stand out?

QUESTION FOR VERONICA GARCIA

Question. As the Secretary of Education for your State, how do you support science and math education for all students? What advice would you give to your counterparts in other States?

QUESTION FOR MARY ANN RANKIN

Question. From what I have read, the UTeach program is strictly for secondary school teachers. Now that it has proven to be successful, are there plans to broaden its scope to include middle and elementary school teachers? What's being done to bring your program to scale throughout the United States?

[**Editor's Note: Responses from Ms. Flanagan, Ms. Garcia, and Ms. Rankin were not available at time of print.**]

[Whereupon, at 11:55 a.m., the subcommittee was adjourned.]

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