THE NATIONAL MATHEMATICS ADVISORY PANEL REPORT: FOUNDATIONS FOR SUCCESS

HEARING

BEFORE THE

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C O N T E N T S

THE NATIONAL MATHEMATICS ADVISORY PANEL REPORT: FOUNDATIONS FOR SUCCESS

Wednesday, May 21, 2008
U.S. House of Representatives
Committee on Education and Labor
Washington, DC

The committee met, pursuant to call, at 10:01 a.m., in room 2175, Rayburn House Office Building, Hon. George Miller [chairman of the committee] presiding.

Present: Representatives Miller, Kildee, Payne, Scott, Woolsey, Hinojosa, Tierney, Kucinich, Wu, Holt, Davis of California, Bishop of New York, Loebsack, Hare, Shea-Porter, McKeon, Petri, Keller, and Foxx.

Staff present: Tylease Alli, Hearing Clerk; Alice Johnson Cain, Senior Education Policy Advisor (K-12); Lynne Campbell, Legislative Fellow for Education; Adrienne Dunbar, Education Policy Advisor; Lloyd Horwich, Policy Advisor for Subcommittee on Early Childhood, Elementary and Secondary Education; Jill Morningstar, Education Policy Advisor; Alex Nock, Deputy Staff Director; Joe Novotny, Chief Clerk; Rachel Racusen, Deputy Communications Director; Margaret Young, Staff Assistant, Education; Mark Zuckerman, Staff Director; Stephanie Arras, Minority Legislative Assistant; James Bergeron, Minority Deputy Director of Education and Human Services Policy; Robert Borden, Minority General Counsel; Cameron Coursen, Minority Assistant Communications Director; Alexa Marrero, Minority Communications Director; Chad Miller, Minority Professional Staff; and Linda Stevens, Minority Chief Clerk/Assistant to the General Counsel.

Chairman MILLER [presiding]. The Committee on Education and Labor will come to order for the purposes of conducting a hearing on the National Mathematics Advisory Panel Report: Foundations for Success.

Twenty-five years ago, the release of A Nation At Risk first opened our eyes to an education system that was threatening our country's global leadership. Decades later, we continue to face serious challenges to our nation's economic competitiveness and future. The Programme for International Student Assessment found that the U.S. lags far behind other developed nations in math and science education.

The National Assessment of Educational Progress scores are also sobering. They show that while the achievement gap is narrowing and elementary students are making some gains in math in lower

grades, only about one-third of our eighth-grade students are at or above proficiency in math. Less than one-quarter of our high school seniors are at or above proficiency in math.

And just 2 months ago, the National Mathematics Advisory Panel released a report on the state of math education and instruction in our country. The panel concluded that our national system for teaching math is "broken and must be fixed" if we are to maintain our competitive edge.

We know that workplaces increasingly require that workers be able to work in teams across communities and continents. The jobs of the future will demand innovators with strong critical thinking and analytical skills. Our students simply won't be able to develop these skills without a solid foundation in math.

Today, we are here to discuss the findings of the National Math Panel's report and how we can improve U.S. math education in a meaningful way. We will closely examine two major shortcomings identified by this panel in how our children are learning and being taught math.

First, we have to raise our standards and expectations for math education. The current structure of the U.S. math curriculum is not conducive to helping students build math skills over time. The curriculum in our nation's schools generally attempts to cover many topics at each grade level, meaning that each topic receives limited instructional time and inadequate concept development. Topics are introduced and then built upon in later years.

By comparison, top-performing nations tend to present fewer topics at each grade level, thus allowing teachers to explore topics in greater depth. This approach encourages students to develop full proficiency in one topic before moving on to more complex topics and allows students to better comprehend the subject at hand.

Second, we are not giving our teachers the training and support needed to provide effective math instruction to students. Teachers cannot be expected to teach what they do not know themselves. We have to provide teachers with opportunities to learn math while they are still in school and to participate in professional development programs throughout their careers.

The panel recommends improving pre-service teacher training, in-service professional development, training and ongoing support for teachers—something I have long believed is fundamental to strengthening the quality of education that students receive.

The best thing we can do to help our kids succeed in math is to invest more in the success of their teachers. I am glad to say that this Congress has taken some important first steps in this direction. Last year, we enacted the America COMPETES Act, which improves teacher education in math, science and other high-need fields.

We also provided up-front tuition assistance of $4,000 per year for outstanding undergraduate students who commit to teaching math or another high-need subject in a high-need school. But as this report reminds us, it will take comprehensive, systemic reforms to improve math education in this country.

This administration deserves credit for convening this panel. However, at a time when we need strong leadership in bolstering the fields of math and science, I am extremely disappointed by re-

ports that this administration may withdraw the U.S. from participation in the Trends in International Mathematics and Science Study, an international exam given to high school students who take advanced placement math and physics courses.

We will not be able to make the well-informed policy decisions needed to keep our nation on the cutting edge of innovation and discovery if we can't measure the performance of our students against the performance of students in other countries. I hope that the administration will reconsider this misguided decision.

Nothing is more important for the future of our country than building a world-class education system that will give every child the opportunity to succeed. I hope that the National Math Panel's report serves not just as a wake-up call, but also as a catalyst for the significant changes needed to help reach that goal.

I want to thank our panel of expert witnesses—I will be introducing them in a moment—for joining us today. We appreciate your time, your effort, and your work with the committee, and we look forward to hearing your testimony.

I would like now to recognize the senior Republican on the committee, Congressman McKeon from California, for his opening statement. The chair also recognizes the presence of a quorum.

Mr. McKeon?

Prepared Statement of Hon. George Miller, Chairman, Committee on Education and Labor

Good morning.

Welcome to today's hearing on "The National Mathematics Advisory Panel Report: Foundations for Success."

Twenty-five years ago, the release of A Nation at Risk first opened our eyes to an education system that was threatening our country's global leadership. Decades later, we continue to face serious challenges to our nation's economic competitiveness and future.

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The best thing we can do to help our kids succeed in math is to invest more in the success of their teachers. I am glad to say that this Congress has taken some important first steps in this direction. Last year we enacted the America COMPETES Act, which improves teacher education in math, science, and other high-need fields.

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But as this report reminds us, it will take comprehensive, systemic reforms to truly improve math education in this country.

This administration deserves credit for convening this panel. However, at a time when we need strong leadership in bolstering the fields of math and science, it is extremely disappointing that this administration recently decided to withdraw the U.S. from participation in the Trends in International Mathematics and Science Study, an international exam given to high school students who take advanced placement math and physics courses.

We will not be able to make the well-informed policy decisions needed to keep our nation on the cutting edge of innovation and discovery if we can't measure the performance of our students against the performance of students in other countries. I hope that the administration will reconsider this misguided decision.

Nothing is more important for the future of our country than building a world-class education system that will give every child the opportunity to succeed.

I hope that the National Math Panel's report serves not just as a wake-up call, but as a catalyst for the significant changes needed to help reach that goal.

I want to thank our panel of expert witnesses for joining us today. I look forward to hearing more about their experiences and recommendations for how we can strengthen math education.

Thank you.

Mr. MCKEON. Thank you, Chairman Miller, and good morning.

I am pleased to be here to discuss the report and findings of the National Mathematics Advisory Panel. Created in April, 2006, the National Math Panel was charged with providing recommendations on the best use of scientifically based research to advance the teaching and learning of mathematics. We know how important it is for our young people to be proficient, indeed to excel, in core subjects, including mathematics.

Like reading, mathematics is a foundational subject. It is one upon which nearly all other learning can be built. In this time of rapidly changing technology, our children must be able to perform well in the subjects that will allow them to succeed. Unfortunately in far too many cases, our children are being out-performed by their peers around the world. We know that educational excellence today means international competitiveness tomorrow.

That is why it is so important that we take steps to improve educational opportunities for all students. I believe today's hearing is an important opportunity to explore the research and findings of the National Math Panel. One of their goals was to provide guidance on how to improve mathematics achievement for all students in the United States.

I would like to hear more about the recommendations they developed and about our ability to implement them in our nation's schools. I would also like to hear directly from the stakeholders whose job it is to put effective mathematics instruction into practice.

From business leaders to classroom teachers, there are millions of individuals who are embracing the cause of educational excellence. I look forward to hearing these perspectives on the importance of a quality math education and the steps that are being taken to ensure it is reflected in classrooms around the nation.

Of course, we all know that one of the most basic goals of the No Child Left Behind Act was to ensure that all children can read and do math at grade level by 2014. More than 6 years after NCLB became law, I think we can see both success and opportunity. It is true that achievement gaps are narrowing and test scores are on the rise. At the same time, we are still far from our goal of universal proficiency.

I think today's hearing will be enlightening as we look to the future of NCLB. We have with us a distinguished panel of experts who can discuss the relevance of NCLB's goals when considered through the lens of the National Math Panel's report.

I want to thank our witnesses for being here today, and again I want to thank Chairman Miller for convening this important hearing.

I yield back.

Prepared Statement of Hon. Howard P. "Buck" McKeon, Senior Republican Member, Committee on Education and Labor

Thank you Chairman Miller and good morning. I'm pleased to be here to discuss the report and findings of the National Mathematics Advisory Panel.

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Chairman MILLER. Thank you very much.

Other members of the committee are invited to submit written statements should they desire to. The rules allow for that.

I would like now to introduce our distinguished panel, and again thank them so very much. I would also like to recognize Professor Bill Schmidt from Michigan for his help in assembling this panel. He gave the committee a lot of good advice about all your talents. So thank you for being here.

Dr. Skip Fennell is a Math Panel member, and the past president of the National Council of Teachers of Mathematics. He is a mathematics education professor at McDaniel College. He is the past president of the National Council of Teachers of Mathematics. In 1990, he was honored as Maryland's outstanding mathematics educator, and the Council for the Advancement and Support of Education and the Carnegie Foundation named Mr. Fennell professor of the year in Maryland in 1997.

Laura Slover has been with Achieve since 1998, shortly after its creation by the governors and business leaders. As vice president of content and policy research, Ms. Slover leads Achieve's work with the states in building mathematics capacity, oversees Achieve's benchmarking initiatives, and directs the organization's research agenda. She has extensive experience in reviewing academic standards in the U.S. and abroad and has written a number of reports and articles on this topic.

Dr. William Haver is going to be introduced by Mr. Scott.

Mr. SCOTT. Thank you, Mr. Chairman.

I am pleased to introduce Dr. William Haver, the professor of mathematics at Virginia Commonwealth University in Richmond, Virginia. He has served as professor of mathematics at VCU since 1992. He previously served as chair of the department for 13 years. He has been nationally recognized for his efforts to improve educational instruction and student learning in mathematics, and has received numerous rewards from state and local organizations.

He is the author of dozens of research papers and articles about education policy, particularly in mathematics. He currently serves as principal investigator for two research studies: Preparing Virginia's Mathematic Specialists and Mathematic Specialists in K-5 Schools: Research and Policy Pilot Study.

He received his B.S. with honors from Bates College, his M.S. from Rutgers University, and Ph.D. in mathematics from the State University of New York at Binghamton. He has previously taught and conducted research in mathematics at Bates College, Rutgers University, the University of Tennessee, and the Institute of Advanced Studies in Princeton, New Jersey.

We appreciate Dr. Haver for being with us today.

Chairman MILLER. Thank you.

Dr. Wanda Staggers is an instructor at the Academy of Engineering and Biomedical Sciences and dean of manufacturing and engineering for Anderson School District Five in South Carolina. Dr. Staggers conducts teacher training at various colleges and universities across the nation and is a master teacher with Project Lead

The Way in two subject areas: principles of engineering and computer integrated manufacturing.

She assists with engineering camps for middle school girls through It's A Girls Thing, a program in which she and a team of female college engineering students visit middle schools once a month to help girls become better informed about their career options.

Dr. Mary Ann Wolf is executive director of the State Education Technology Directors Association, which provides national leadership in education technology, ensures members have meaningful professional development opportunities, and engages in partnerships with the public and private sector to collaborate on how educational technology supports teaching and learning.

Dr. Wolf has led the national leadership summits in which her members and partners develop tools for the education community. She directs the technology assistance partnership program with nine federal evaluation grantees, and overseas, the national trends report focused on NCLB Title II, part (D), Enhancing Education Through Technology Program. Thank you for doing that.

John Castellani, thank you so much for being here. We know you came on very short notice. Unfortunately, we had a cancellation of a representative of IBM, and we thank you so much for coming and representing the Business Roundtable.

He is representing the Business Roundtable, an association of chief executive officers leading U.S. corporations with a combined workforce of more than 10 million employees, and $4.5 trillion in annual revenues. The Business Roundtable has been cited by the Financial Times as the most influential chief executive lobbying group in the United States, and is in the forefront of public policy debates advocating for a vigorous, dynamic global economy.

Prior to becoming president of the Business Roundtable, Castellani was executive vice president of Tenneco Company and part of the senior management team that led the transformation of an ailing conglomerate into seven strong companies. So we expect miracles from you today. And thank you for the involvement of the Business Roundtable. We had a very good session yesterday on community colleges over on the Senate side, and again thank you for that participation.

Dr. Fennell, we are going to begin with you. We have a light system here. When you begin speaking, a green light will go on. That tells you that you have 5 minutes. At some point, an orange light will go on, which means you have about 1 minute remaining. We would like you to think about wrapping up your remarks, but we want you to finish them in a coherent fashion. And then the red light will go on and we would appreciate you at that point stopping so that we can hear and allow for questions.

Thank you so much for joining us. Tell us all you know in 5 minutes. [Laughter.]

STATEMENT OF SKIP FENNELL, MEMBER, NATIONAL MATHEMATICS ADVISORY PANEL, PAST PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Mr. FENNELL. Good morning, Chairman Miller and Congressman McKeon. As noted, my name is Francis "Skip" Fennell. I am pro-

fessor of education at McDaniel College in Westminster, Maryland, and recent past president of the National Council of Teachers of Mathematics, and a recent member of the National Mathematics Advisory Panel.

As you noted, the National Math Panel was appointed by the president to advise the secretary and the president on the best use of scientifically based research to advance the teaching and learning of mathematics. The panel was charged with making recommendations on improving mathematics achievement for all students, with a focus on preparing students for success in algebra.

This report has 45 recommendations. To distill those 90 pages in 5 minutes is somewhat of a challenge. So what I am going to do is, if you will, give you snapshots of particular issues that are critically important to all of this.

You mentioned in your opening remarks the concern we have relative to curriculum structure around this country. In a nutshell, classroom teachers today are faced with far too many objectives and expectations. There are states in this country that have well over 100 expectations or objectives in a given instructional year. You cannot do that well.

One of the things that the panel did was take a look at what does it take to get kids to be successful in algebra. Building off the work of the National Council of Teachers of Mathematics curriculum focal points, distilled, what we refer to as critical foundations for algebra. That is, when students get into that course called algebra, whether it is a course with algebra as its title or within an integrated mathematics curriculum, they really need to know and know well everything possible about working with whole numbers, everything possible about working with fractions—fractions being defined here as fractions, decimals, percent, ratio, leading on to work with proportion, and then also particular aspects of geometry and measurement.

Not that that is all of what they would experience prior to algebra, but these are, if you will, the must-haves. So that is really important to us in our critical foundations and our benchmarks, which are suggestive of particular grade placement, go into that as well.

We note that one of the reasons for the panel's existence was to help define algebra and recognize the importance of algebra. Algebra is clearly a gateway or passport, if you will, to higher level mathematics. Students who complete algebra II are more than twice as likely to graduate from college compared to students with less mathematical preparation. This is particularly true among African American and Hispanic students.

I am certain that you will hear more about the gateway nature of algebra in a few minutes from Laura Slover here, with her work relative to Achieve.

We have known for some time that teachers make a difference. Well, of course. What we don't know, and what we need to know, is what is it about effective classroom teachers that we can bottle? What is it about effective professional development that we can use in places around this country? The research needs in that particular area are critical, and it is a tremendous call, in my opinion,

for teacher education around this country, both at the pre-service level and in-service as well.

One aspect of our work with teachers is the recognition that we should consider, at the very least, elementary math specialists—that is a person who has a specialist background in mathematics at the elementary level. You will soon hear comments from Bill Haver from Virginia Commonwealth regarding that state's model program that is statewide and will engage all of us in an important initiative.

But let me add the following: At a time of teacher surplus at the elementary school level, it is perhaps time to consider scrapping the model of the elementary teacher as generalist. Why not have specifically trained elementary math specialists starting from day one of their career?

I would like to make a few statements about learning. One of the issues at the core of what has become known in education circles at the "math wars" has been a discussion, some would argue a debate, around conceptual understanding, skill development, and problem solving. What is important here? Well, all of it. This is not an either-or proposition.

The National Math Panel has stated very clearly that understanding mathematics conceptually, becoming proficient in the use of procedures, and extending this to understanding and proficiency to solve problems must be developed simultaneously. Students, all students, need to make sense of the mathematics they are learning. How better to do that than to solve problems involving mathematics, whether that is deciding the impact of that 5 percent finance charge or that seemingly day-to-day increase at the gas pump.

A very important message from the panel's report addresses an issue that frankly drives me crazy. Mathematics is important for every student in every classroom in this country regardless of grade level, gender, race or ethnicity. This is not a "for nerds only" subject. It is a "for everyone" opportunity. There is no math gene.

One of the most important findings in the Math Panel's report is that effort matters. So once and for all, we need to stop the parent conference that begins with the phrase, "Well, you know, I was never good in math either." Math is important for our culture, for our country and for our children.

In addressing its charge from the president, the National Math Panel's work was very much directed by research. However, the panel found that far more educational research is needed. Research of all kinds and types must drive what we do in this field of mathematics education.

Importantly, in No Child Left Behind, with AYP looming every year, pre-K through 12 schools should be provided with incentives and resources to provide venues for and encourage collaboration in educational research. We need to find ways to make this happen.

And finally, the America COMPETES legislation calls for funding a Math Now initiative for $95 million to improve mathematics instruction at the elementary and middle school levels. I encourage you to support this initiative and move it forward.

Thanks for this opportunity. I look forward to your questions later.

[The statement of Mr. Fennell follows:]

Prepared Statement of Francis (Skip) Fennell, McDaniel College, Past President, National Council of Teachers of Mathematics

Good morning, Chairman Miller and Congressman McKeon. My name is Francis (Skip) Fennell. I am a professor of education at McDaniel College in Westminster, Maryland. I am also past president of the National Council of Teachers of Mathematics (NCTM). From my appointment in April 2006 until last month, I also served as a member of the National Mathematics Advisory Panel.

First, thank you for the opportunity to speak with you about the work of the National Mathematics Advisory Panel and its report, "Foundations for Success," which was released on March 13. The National Math Panel was appointed in 2006 by President Bush to advise the President and the Secretary of Education on the best use of scientifically based research to advance the teaching and learning of mathematics. The Panel was charged with making recommendations on improving mathematics achievement for all students, with a focus on preparing students for success in algebra.

I won't belabor what you've already heard about the growing concern about our nation's standing in a global marketplace and the importance of the education in the STEM fields—that's science, technology, engineering and mathematics—to that standing. The concerns about how our students compare with those of other countries are well documented and one of the reasons the National Math Panel was formed. And the importance of mathematics, specifically algebra, as a foundation for success of all kinds is almost universally acknowledged.

My comments will focus on a few major themes from the report. But I will state that there is a great deal more in the report's 45 recommendations and related findings, which can guide mathematics education in the future.

Curriculum Focus and Coherence

One of the most significant challenges in mathematics education today is the need for curricular focus and coherence. Teachers today are guided by state curriculum standards that sometimes more than 100 learning expectations per grade level. Consequently, to get through all of these expectations, teachers address topics superficially rather than in depth, and learning suffers. The Math Panel's report acknowledges the need for a more focused, coherent curriculum in grades pre-K—8 that is streamlined and emphasizes a well-defined set of the most critical topics in the early grades.

By focused, the Panel means that curriculum must include (and engage with adequate depth) the most important topics prerequisite for success in school algebra. These are the Panel's Critical Foundations for Algebra and accompanying benchmarks. By the term coherent, the Panel means that the curriculum is marked by effective, logical progressions from earlier, less sophisticated topics into later, more sophisticated ones. Improvements like those suggested in the report promise immediate positive results with minimal additional cost.

The National Council of Teachers of Mathematics (NCTM) advocates for a broad vision of the mathematics for all students at these levels; it also recognizes the necessity for focus and coherence within a prekindergarten through grade 8 mathematics program. NCTM's Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence describes the need for a coherent set of mathematics topics that are important for all students to acquire at particular grade levels in order to prepare for the study of algebra as well as other important mathematics. It presents the most important mathematical topics for each grade level. The Panel's Critical Foundations and accompanying benchmarks are consistent with NCTM's Curriculum Focal Points and are connected as prerequisites for algebra.

Fractions

Some would argue that fractions may be the most critical of the Panel's Critical Foundations for algebra. Fractions are defined here as fractions, decimals, and percent, leading to work with ratio and proportion. Several of the Panel's task groups, as well as the Panel's teacher survey, substantiated that difficulty with fractions is pervasive and an obstacle for far too many students to success in algebra.

A nationally representative sample of over 700 teachers of Algebra I who were surveyed for the Panel rated students as having very poor preparation in "rational numbers and operations involving fractions and decimals." As with learning whole numbers, a conceptual understanding of fractions, decimals, and percent, proficiency

with their use, and the opportunity to solve problems with fractions is mutually reinforcing.

Effort Matters

Another important message from the Panel report addresses a cultural issue that seems to have gained more prominence in the United States, and that's the fallacy that there is some "math gene" that endows some students with an affinity to learn mathematics. There is no such math gene. Rather, research shows that students in other countries devote more effort to mathematics learning, and learn more as a result. One of the most important findings in the Math Panel's report is that effort matters. Grappling with challenging math problems, even if they are not "solved," leads to greater understanding and more learning, on the part of all students. So, once and for all, we need to stop the parent conference that begins with the phrase, "Well, you know I was never good in math either." Math is important—for our children and for our country.

Conceptual Understanding

One of the issues at the core of what has become known in education circles as the "Math Wars" is the debate over conceptual understanding and basic skills. In the highly charged lexicon of the two sides on the math wars, it is not an either/or proposition. The National Math Panel has stated very clearly that understanding mathematics conceptually, becoming proficient in the use of procedures, and extending this understanding and proficiency to solving problems must be developed simultaneously. In short, as students learn mathematics they need to have the mutually reinforcing benefits of conceptual understanding, procedural fluency, and the opportunity to solve problems applying and extending the mathematics learned. Students—all students—need need to make sense of the mathematics they are learning and become proficient in that mathematics, and how better to do that than solving problems that involve mathematics—whether that's deciding the impact of that 5 percent finance charge or the, seemingly daily increase in gasoline prices.

Early Learning

Another finding from the Panel's work is that there are significant advantages for children to have a strong start in engaging with and learning mathematics very early. A high-quality, challenging, and accessible mathematics education provides early childhood learners with a critically important, vital foundation for future understanding of mathematics. Young children in every setting should experience effective, research-based curricula and teaching practices. Teachers should connect ideas within mathematics as well as with other subjects, and they should encourage children to communicate, explaining their thinking as they interact with important mathematics in deep and sustained ways. Early childhood educators should actively introduce mathematical concepts, methods, and language through a range of appropriate experiences and teaching strategies.

Algebra as Gateway

One of the reasons for the focus on algebra in the Panel's charge from the President is that Algebra is clearly a passport or a demonstrable gateway to higher level mathematics. Moreover, research shows that completion of Algebra II correlates significantly with success in college and future employment earnings. In fact, students who complete Algebra II are more than twice as likely to graduate from college compared to students with less mathematical preparation. Among African-American and Hispanic students with mathematics preparation at least through Algebra II, the differences in college graduation rates versus the student population in general are half as large as the differences for students who do not complete Algebra II. As one panelist suggested at the release of the Panel report, the content (the mathematics) is king here. We need a more focused, coherent curriculum for all students—with particular emphasis on points of focus that are foundational for success in algebra.

Excellence in mathematics education rests on equity—high expectations, respect, understanding, and strong support for all students. Policies, practices, attitudes, and beliefs related to mathematics teaching and learning must be assessed continually to ensure that all students have equal access to the resources with the greatest potential to promote learning. A culture of equity maximizes the learning potential of all students.

Teachers

We have known for some time that the single most important factor in mathematics learning is teacher quality. Unfortunately, little is known from existing high-quality research about what effective mathematics teachers do to generate greater gains in student achievement. This is one of several fields in which the Panel found

that further research is needed. Regarding teaching, research is needed to identify and more clearly define the skills and practices underlying these differences in teachers' effectiveness, and how to develop them in teacher preparation programs. We must be able to tell what works in teacher education and frankly what's need to prepare and retain our best teachers. This, to me, represents a clarion call for teacher education—at every level.

Math Specialists

In an attempt to improve mathematics learning especially at the elementary level, a number of school districts around the country are using mathematics specialists. While the terms math specialist and math coach are not always clearly or consistently defined, there is potential in this movement. The Panel's recommendation for mathematics specialist teachers is based on the success of this particular model. The Panel identified three different types—math coaches (lead teachers), full-time elementary mathematics teachers, and pull-out teachers. Some of these show promise and should be examined more closely to determine how they can be increased in scale.

The Panel recommends that research be conducted on the use of full-time mathematics teachers in elementary schools. These would be teachers with strong knowledge of mathematics who would teach mathematics full-time to several classrooms of students, rather than teaching many subjects to one class, as is typical in most elementary classrooms. This recommendation for research is based on the Panel's findings about the importance of teachers' mathematical knowledge. The use of teachers who have specialized in elementary mathematics teaching could be a practical alternative to increasing all elementary teachers' content knowledge (a problem of huge scale) by focusing the need for expertise on fewer teachers. However, I would add that at a time of teacher surplus at the elementary school level, it is perhaps time to scrap the model of elementary teacher as generalist. Why not have specifically trained elementary mathematics specialists starting from day one of their career? Our country can't wait until such specialists are graduate students.

Research

In conformity with its charge from the President, the National Math Panel's work was very directed by research. In short, it found that much more educational research of almost all kinds is needed. This includes research relative to the impact of technology on the teaching and learning of mathematics. This means all technology—software, the use of graphing calculators, and the role of the Web. Technology continues to expand and infiltrate our lives, often without any documentation of its impact. How do we both acknowledge and harness the promise of technology as a tool for teaching and learning?

Support should be provided to encourage the creation of cross-disciplinary research teams, including expertise in educational psychology, sociology, economics, cognitive development, mathematics, and mathematics education. In short, we need more expertise at the table.

Most important, in an NCLB world with AYP looming each year, Pre-K—12 schools should be provided with incentives and resources to provide venues for, and encourage collaboration in, educational research.

New funding should be provided to establish support mechanisms for career shifts (K, or career development, awards from the National Institutes of Health represent one example). Many accomplished researchers who study the basic components of mathematics learning are not directly engaged in relevant educational research. While this more basic kind of research is important both in its own right and as a crucial foundation for designing classroom-level learning projects, at least some of these investigators have the potential to make more directly relevant contributions to educational research. Consequently, providing incentives for them to change the emphasis of their research programs could enhance research capacity in the field.

We strongly encourage capitalizing on the work that is currently being accomplished on learning and educational practices by the National Science Foundation. This work can augment and improve current instructional practice and student learning.

As you know, Congress last year showed strong bipartisan support for increased investments in strengthening and improving STEM education programs through enactment of the America COMPETES Act. That bill authorized Math Now, which embodies a number of the Math Panel's recommendations, and also recommends an increased investment in programs at the National Science Foundation. Programs under the Foundation's Education and Human Resources Directorate—the division of the NSF that administers the Math and Science Partnerships program, the Noyce Scholarship Program and other important education initiatives—would receive $995

million if appropriators followed the recommendations of the authors of that bill. I encourage Congress to do just that.

There are programs at other federal agencies that also yield benefits for the field of mathematics education, math educators, and students. The Department of Energy is engaged in creating opportunities for students and educators to participate in the nation's research enterprise as a means to improving the competitiveness of U.S. industry and overall scientific literacy through programs at the Office of Science's Workforce Development for Teachers and Scientists. Those efforts, which include exciting opportunities for K—12 math and science teachers, warrant federal support and investment as well.

Math Now

The America COMPETES legislation calls for funding a Math Now initiative for $95 million to improve math instruction in the elementary and middle grades and to provide targeted help to struggling students so that all students can reach grade-level mathematics standards. Math Now will give teachers research-based tools and professional development to improve elementary and middle school students' achievement in mathematics and help mathematics teachers to teach students who are the hardest to reach. These innovations are sorely needed. The early years of mathematics education are foundational to success in algebra, that critical gateway not only to future learning and educational success in every STEM field, but for a better, stronger workforce, and a stable, well-informed citizenry. I strongly encourage Congress to fund this initiative, which would support the end result of much what we're here to talk about today—student learning of mathematics.

Thank you again for your invitation to address the committee and for this opportunity. I would be glad to answer any questions you might have relative to the work of the Panel, the work of the National Council of Teachers of Mathematics, or my own work as a mathematics educator with more than 40 years of experiences as a classroom teacher, principal, supervisor of instruction, and teacher educator.

Chairman MILLER. Ms. Slover?

STATEMENT OF LAURA SLOVER, VICE PRESIDENT, ACHIEVE, INC.

Ms. SLOVER. Thank you, Mr. Chairman and members of the committee for the opportunity to Achieve to testify today at this hearing to discuss the importance of mathematics for all students, and to discuss the progress that has occurred in the states on this front.

We also want to commend the National Mathematics Panel for its fine work in this area.

So I am going to talk about what states are doing to move the needle on mathematics education. I want to tell you a little bit about Achieve. Achieve is a bipartisan nonprofit organization created by the nation's governors and business leaders to help states raise academic standards, improve assessments, and strengthen accountability, and to prepare all students for post-secondary education careers and citizenship.

I am actually talking a little bit off these slides, if you want to look at those.

One of our primary goals is to address the expectations gap in which students are graduating from high school, and yet getting to college or getting to their first job without the requisite skills and knowledge necessary to succeed. Achieve has done research to identify what it does take to succeed in mathematics and in English to be prepared for life after high school, whether students attend college or go directly into a job.

To do that, we ask college professors and employers what was most important for students to know. The result was a set of benchmarks in mathematics and English that contains the content knowledge that all students should know.

In 2005, Achieve launched the American Diploma Project Network, then a group of 13 states dedicated to a college and career-ready policy agenda. The take-up rate for this agenda has been remarkable. Today, the network includes 33 states, reaching 80 percent of the nation's public school students.

Those 33 states are committed to an agenda that includes aligning high school standards with what it takes to succeed in college and careers, requiring all students to take that rigorous set of courses aligned with those standards, incorporating college-ready tests into their state testing systems, and holding high schools accountable for graduating students who are ready for college and careers, and then also really pushing on the higher ed community to hold their institutions accountable for the success of incoming students.

So what should students learn in high school to be successful in college and careers? Our research found that students should master 4 years of grade-level English and 4 years of mathematics with content equivalent to a sequence that includes algebra I, geometry, algebra II, data analysis, and statistics. This level of content is reflected in Achieve's American Diploma Project benchmarks, and Dr. Fennell alluded to that just a moment ago.

So why is higher level mathematics important for all students? Algebra II or its equivalent is a gateway course for higher education and it teaches quantitative reasoning skills important for the workplace. Achieve's research shows that higher level math courses such as algebra II improves access to post-secondary education, are critical for college success, and are important to many careers including those that don't actually require a 4-year college degree.

Students who complete such course work are not only better prepared for work, they earn higher salaries. It really is true that the more math you learn, the more money you earn. Unfortunately, there is still a large achievement and opportunity gap in math. Disadvantaged and minority students, for whom rigorous math courses can really make the most difference, earn fewer math credits and are less likely than their peers to enroll in higher level math courses.

The good news in the states is that when ADP first was formed, we didn't see a lot of states who were moving forward on this agenda. At that time, only two states had set their high school graduation requirements at a career and college-ready level. Today, 19 states and the District of Columbia have set their graduation requirements to the college and career-ready level, which will help ensure that students are prepared for the challenges they meet when they graduate from high school. Eleven additional states are reporting that they plan to do so in the coming years.

There has also been a trend across the country for states to become more specific about the math content in courses they require all students to complete. In the past, states tended just to require a number of years of math without specifying what math students were to take. In 2005, for example, 30 states did not even require students to complete algebra I, let alone higher level courses like algebra II.

Now, 30 states and the District of Columbia have specific course-taking requirements in mathematics. Nineteen of those states and D.C. require students to complete algebra I, geometry, and algebra II or an equivalent sequence, and two states—Arkansas and Alabama—require students to take a fourth math course beyond algebra II. Most of those states have also put in place strong content standards to guide their work.

As states make strides in improving the rigor of their standards and graduation requirements, a number of challenges emerge, particularly in the development of college-ready assessments and supporting materials for educators. Achieve is engaged in a number of efforts to help states in their work, most notably a common algebra II end-of-course exam. This is the largest-ever multi-state assessment with 14 participating states and over 110,000 students who took the first exam this spring and are currently taking it right now.

This exam provides states with the ability to measure college-ready mathematics content, ensuring the consistency of content and rigor in algebra II courses within and among states so algebra II is the same regardless of where a student happens to go to school. It will enable comparisons of performance across states and hopefully over time provide colleges with a measure of readiness for placement into post-secondary credit-bearing courses.

In addition to the algebra II exam, Achieve has a number of other efforts underway to help states, including an algebra I exam, a number of math tools including mathematics benchmarks for K through 12, model course sequences, sample classroom problems, examples of fourth-year courses, and workplace tasks that are actually tied to the application of mathematics.

Achieve also provides advocacy tools for states such as mathematics-at-work brochures, white papers and other tools to help states make the case that advanced mathematics is very important, as Dr. Fennell stated earlier, and as I have just testified to.

In closing, I would like to leave you with a few thoughts about major trends in math education that Achieve has encountered as we work across the states. First of all, algebra II is the new algebra I. Every student needs to have it. But it is not your grandfather's algebra II that I am talking about. We need to find new and innovative ways to teach it so that we can reach more students, ways that emphasize conceptual understanding and not just straight procedures.

Finding new ways to present and make mathematics more relevant to students without diluting its rigor will enable more students to be prepared for college and good careers. Along those lines, more states and districts are contemplating organizing high school mathematics into integrated course sequences and they are really putting in energy and thinking carefully about how to revamp the career and technical programs so that mathematics is a major part of it.

Another thing we have learned is that employers and post-secondary faculty place a high value on the nontraditional mathematics, like statistics, probability and data analysis. States are increasingly interested in ensuring that their mathematics standards are internationally benchmarked, as Chairman Miller mentioned in

his own remarks. Achieve is currently working in that regard to look at the standards in the world's highest performing countries.

Finally, I will just close by saying if we think about how we are going to really raise the bar on mathematics education, it is going to come down to teacher quality and teacher capacity. It is one of the greatest challenges we have in making more advanced math classes available to more students at the secondary level, and it is an area in which we have a lot of work ahead of us.

Thank you for the opportunity to testify today, and I look forward to answering your questions.

[The statement of Ms. Slover follows:]

Prepared Statement of Laura Slover, Vice President, Achieve, Inc.

Thank you Chairman Miller and members of the Committee for the opportunity for Achieve to testify today at this hearing to discuss the importance of mathematics for all students and the significant progress that has occurred in the states on this front. We also want to commend the work of the National Mathematics Panel for their excellent work.

Created by the nation's governors and business leaders, Achieve is a bipartisan non-profit organization that helps states raise academic standards, improve assessments and strengthen accountability to prepare all young people for postsecondary education, careers, and citizenship. Achieve was created to address the expectations gap: the alarming trend that allows students to graduate from high school without the requisite skills and knowledge necessary for success in college and the workplace.

From 2001 to 2004, Achieve undertook a major research endeavor to identify the must-have skills and knowledge all students need in the core subjects of mathematics and English to be prepared for life after high school. The result of this project—known as the American Diploma Project (ADP)—was an agreed upon set of benchmarks in mathematics and English that all students should know by the time they graduate high school, as defined by the postsecondary and business communities. To cover the content in the ADP benchmarks, high school students need to take four years of grade level English and four years of mathematics with content equivalent to a sequence that includes Algebra I, Geometry, Algebra II, Data Analysis, and Statistics. In 2005, Achieve launched the American Diploma Project Network, then a group of 13 states dedicated to a college- and career-ready policy agenda. Today, the Network includes 33 states, reaching 80% of our public school students.

Why higher-level math for all students?

As revealed by Achieve's research, there are many specific skills and competencies that young people will need to succeed, but more than particular skills, students need the cognitive capacity to educate themselves throughout their entire lives. Young people need the ability for complex reasoning and the self-confidence to apply it in any and all situations. These are precisely the skills that are developed in higher-level mathematics courses, beginning with the foundational Algebra I and extending beyond Algebra II, in which students begin to use abstract reasoning to solve complex problems.

Beyond the unmistakable intellectual benefits of students taking higher-level math courses, there are a number of practical benefits of engaging in rigorous math coursework. Achieve and others have found that Algebra II (or an integrated course that covers the same content) is a gateway course for higher education and teaches quantitative reasoning skills important for the workplace. Achieve's research shows that higher level mathematics courses such as Algebra II improve access to postsecondary education, are critical for college success, and are important to many careers—including those that don't require a four-year college degree. Students that complete such coursework are not only better prepared for work, they earn higher salaries. Achieve's conclusions, as reflected in its mathematics benchmarks (Ready or Not: Creating a High School Diploma That Counts)), have been reinforced by other research, such as ACT.

Unfortunately, there is still a large achievement and opportunity gap in mathematics. Disadvantaged and minority high school students earn fewer mathematics credits than their socio-economically advantaged peers, and are less likely than those peers to enroll in higher-level math courses, such as trigonometry and calculus. The gaps in course-taking by population subgroup mirror those seen in test

scores and other measures of educational outcomes. Black and Hispanic students are twice as likely as their White and Asian peers to take no math beyond the basic level, for example. Additionally, many minority students and girls, of all races and ethnicities, lack access to advanced math classes or are discouraged form enrolling in them. Under these circumstances, higher-level math courses function not as the intellectual and practical boost they should be, but as a filter that screens students out of the pathway to success.

Progress in the states

Since 2005, when the ADP Network was first formed, we have seen significant progress from the states in moving forward a rigorous college- and career-ready policy agenda, particularly in the areas of academic standards and graduation requirements.

High School Mathematics Standards

Rigorous college- and career-ready academic standards are critical as they provide a foundation for decisions on curriculum, instruction and assessments, and they community core learning goals to teachers, parents and students. Although the standards-based reform movement has been going strong since A Nation at Risk was published, the concept of anchoring end-of-high school academic standards to the expectations of the postsecondary and business communities is a relatively new one, yet it has a lot of momentum across the country.

Nineteen states have aligned their high school math standards with the expectations of college and industry and another 25 states and the District of Columbia are in the process of, or plan to, align their standards in coming years, including 13 states that anticipate adopting new math standards by the end of 2008. Put another way, all but six states are looking to improve the transition from high school into postsecondary and workplace settings through the adoption of college- and career-ready standards. An interesting byproduct of aligning to college and career ready mathematics expectations is that the states also share a common core.

High School Graduation Requirements

In 2005, just two states had set their high school graduation requirements at a college and career—ready level, which includes four years of grade level English and four years of rigorous math, including content typically found in Algebra II. Today, 19 states and the District of Columbia have set their graduation requirements to the college- and career-ready level, ensuring students will be prepared for whatever challenges they face upon graduation. 11 more states report plans to move in this direction in coming years.

Even more broadly, there has been a trend across the nation for states to become more specific about the math content and courses they require all students to complete before graduating. In 2005, 30 states did not require students to complete even Algebra I, let along higher-level courses such as Algebra II. Now, 30 states and the District of Columbia have specific course-taking requirements in mathematics. Nineteen of those states, and the District of Columbia, require students to complete Algebra I, Algebra II, and Geometry, or an equivalent sequence, and two of those states (Arkansas and Alabama) require students to take a fourth math course beyond Algebra II.

Achieve: Supporting states to close the math expectations gaplc

However, as more states make strides in improving the rigor of their academic standards and their graduation requirements, a number of challenges emerge, particularly in the development of college-ready assessments and supporting materials for educators and students to ensure all students are prepared for higher-level math course-taking. Achieve is engaged in a number of efforts to help states address these challenges, more notably the common Algebra II end-of-course exam.

ADP Algebra II End-of-Course Exam

In 2005, a number of states in the ADP Network began exploring the possibility of collaborating on a common Algebra II assessment to:

- Measure "college-ready" content;
- Ensure consistent content and rigor in Algebra II courses within and among states;
- Enable comparisons in performance among the states;
- Reduce test development costs; and
- Develop a possible instrument for placement into postsecondary courses.

By 2006, nine states joined the common Algebra II end-of-course consortium, representing an unprecedented multi-state effort. Since then, five additional states have joined this group. These 14 states have worked together—with high school and

higher education mathematics faculty—to agree on the content and design of the assessment, as well as common performance levels to be used across the states. The assessment includes multiple choice, short answer and extended response items and is aligned with the ADP mathematics benchmarks. This represents a significant change for some states as many existing high school exit exams only cover math content taught at the 8th-, 9th- or 10th-grade level.

Beyond the core Algebra II assessment, the group of states also created items for modules that would extend the rigor and scope of the exam. The modules cover topics such as Data & Statistics, Logarithmic Function, and Matrices.

The first administration of this exam occurs this spring, from May 1-June 13, 2008. Over 110,000 students across the participating states will take the exam. States are still crafting policies around which students will be required to take the exam, what stakes they will attach to it, and how the assessment may be used to place students into credit-bearing postsecondary courses. Achieve expects there to be a range of policies adopted throughout the 14 states.

All participating states hope to use the common Algebra II exam to improve curriculum and instruction in high schools. They are also interested—and working with postsecondary leaders—to determine whether the exam can serve as a measure of readiness and placement in credit- bearing college courses.

Moving forward, a subset of the Algebra II end-of-course consortium are now working to develop an Algebra I end-of-course exam to improve curriculum and instruction, help schools determine if students are ready for Algebra II and other higher-level math courses, and compare performance and progress among the participating states. This assessment will be field tested in fall of 2008 and first administered in spring 2009.

Mathematics Benchmarking and Additional Tools

As the ADP benchmarks are intended to cover the four years of high school, over the years, states requested more detail about the progression of content and skills students would need to master through the grades in order to meet the end-of-high school ADP benchmarks. To address this, Achieve has "backmapped" the ADP Mathematics benchmarks from grade 12 down through Kindergarten.

Achieve also has partnered with the Charles T. Dana Center at the University of Texas, Austin to develop accompanying tools and resources to support these backmapped benchmarks. The joint Achieve/Dana Center website includes:

- The ADP benchmarks and back mapping;
- Model math course sequences and grade level standards;
- A supply of sample instructional tasks;
- Criteria and models for fourth-year capstone math courses for students who have completed Algebra II or its equivalent;
- Workplace tasks tied to the application of mathematics; and
- Practices Worthy of Attention that highlight promising programs and instructional models.

Math Works: Advocacy Kit

In addition to the technical assistance Achieve provides to states, Achieve also offers advocacy tools to promote higher-level math course-taking. Most recently, Achieve developed a series of Mathematics at Work brochures to examine how higher-level mathematics is used in today's workplaces. The brochures present case studies drawn from leading industries nationwide to illustrate the advanced mathematics knowledge and skills embedded in jobs that offer opportunities for advancement and are accessible to high school graduates.

Achieve has also recently published a new policy paper—The Building Block of Success: Higher-Level Math for All Students—to synthesize the current research base on why math is so important to all students in regards to college access and success, workplace- and career-readiness, and personal and U.S. competitiveness.

Both the brochures and policy paper, along with to-be-developed one-pagers, PowerPoint slides, and a resource bank, will be included in Achieve's Math Works advocacy kit, which will be rolled out in the summer of 2008. The goal of Math Works is to provide states with the resources they need to ensure all students have the opportunity to engage in rigorous math course-taking throughout their high school experiences.

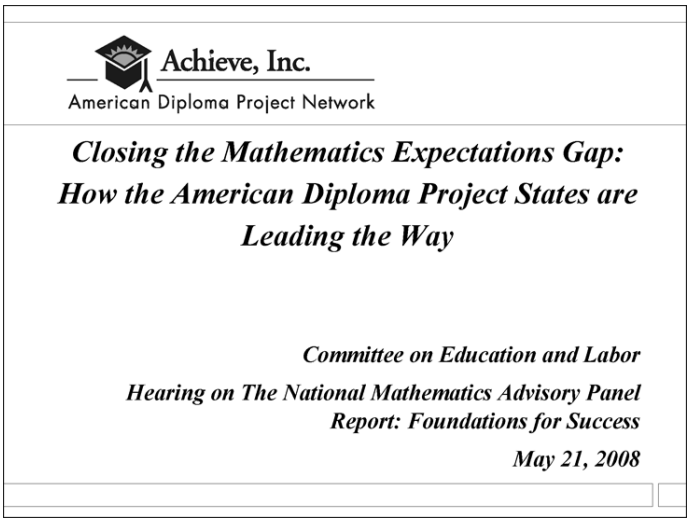
Emerging themes in mathematics education

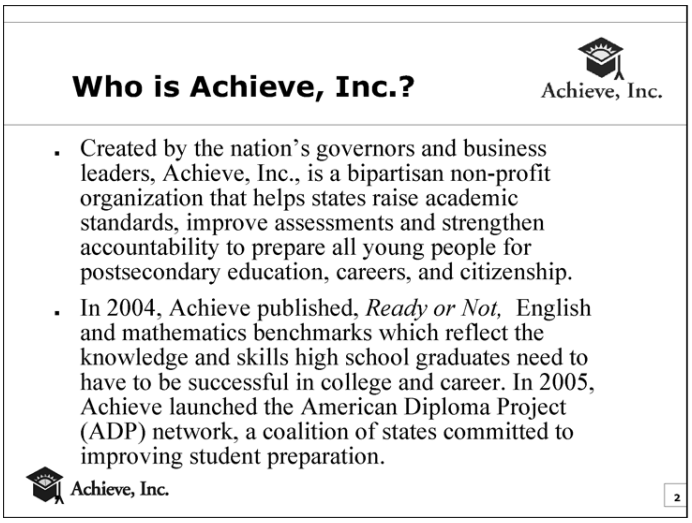
I'd like to leave you with a few major trends in mathematics education that Achieve has encountered as we work with states to reform their mathematics requirements so that more high school graduates are prepared for college and career:

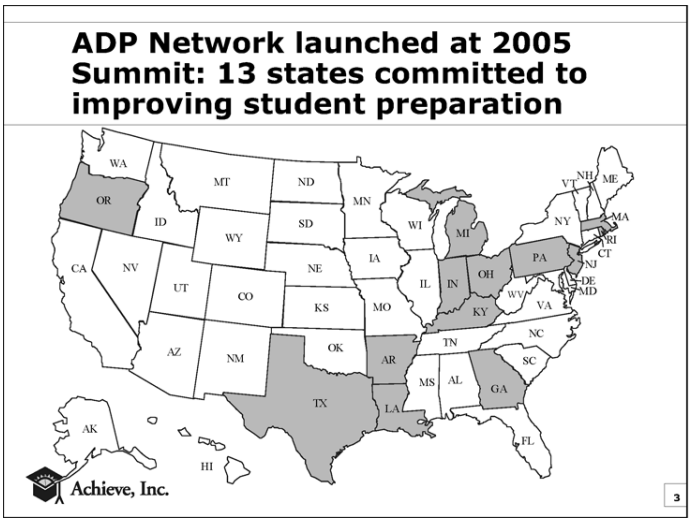
- Algebra II is the new Algebra I, but not your grandpa's Algebra II.

• More states and districts are contemplating organizing high school mathematics in integrated courses rather than the traditional sequence.
• Finding new ways to present and make mathematics relevant to students (integrated courses, career and technical education) without diluting rigor will enable more students to be prepared for college and good careers.
• Employers and postsecondary faculty place a high value on statistics, probability and data analysis.
• States are increasingly interested in ensuring that their mathematics standards are internationally benchmarked to the highest performing countries in the world. Achieve is currently conducting a study to benchmark our mathematics standards and NAEP against the highest performing countries.
• Teacher capacity is one of the greatest challenges in making more advanced mathematics classes available to more students at the secondary level.

[Additional material submitted by Ms. Slover follows:]






ADP Network launched at 2005 Summit: 13 states committed to improving student preparation
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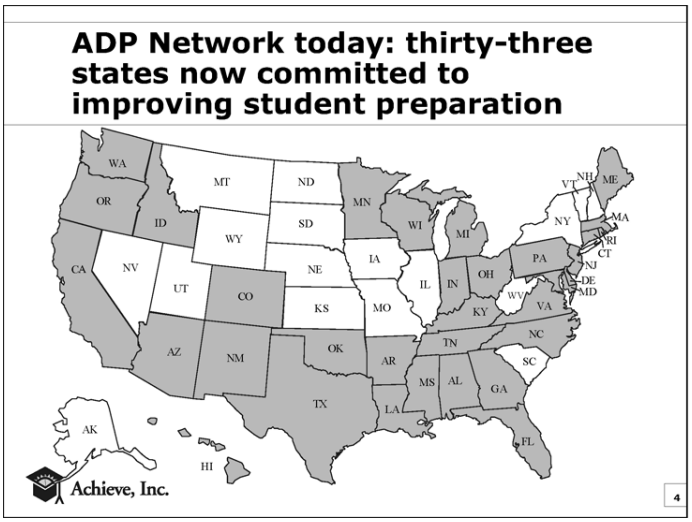
ADP Network today: thirty-three states now committed to improving student preparation
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Closing the Expectations Gap: ADP Network Policy Agenda

- Align high school standards with college and career expectations.
- Require all students to take curriculum aligned with standards.
- Include "college-ready" tests, aligned with state standards, in high school assessment system.
- Hold high schools accountable for graduating students college- and career-ready, and hold postsecondary institutions accountable for student success.

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The ADP Recommended College- & Career-ready Curriculum

- Achieve's research suggests that for high school graduates to be prepared for success in postsecondary settings, they need to take:
  - Four years of challenging mathematics—through the content typically taught in Algebra II, or its equivalent, and beyond, and
  - Four years of rigorous English aligned with college and career ready standards.
- In 2005, only 2 states had graduation requirements at this level.
- As of May 2008, 19 states plus the District of Columbia have graduation requirements at the level.

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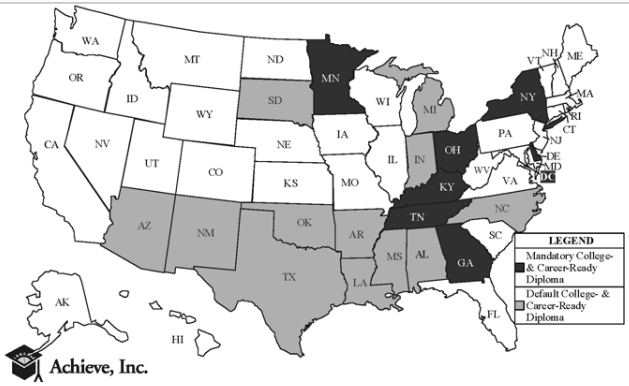
Nineteen States & DC Require a College- & Career-ready Diploma (as of May, 2008)



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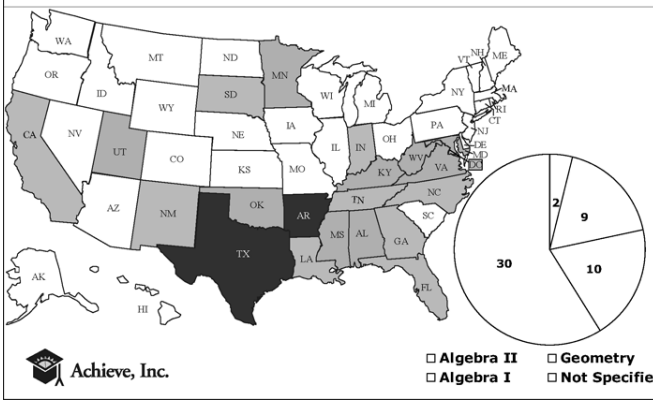
State Mathematics Requirements 2005



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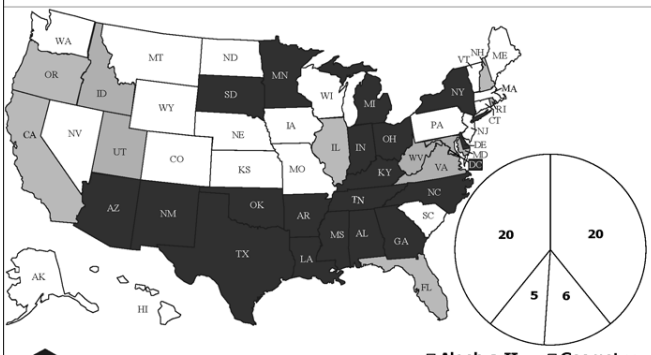
State Mathematics Requirements 2008



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Closing the Mathematics Expectations Gap

Achieve Projects to Assist States In Improving Mathematics Achievement:

- Algebra II End-of-Course Exam
- Algebra I End-of-Course Exam
- Achieve-UT Dana Center joint website www.utdanacenter.org/k12benchmarks math benchmarks, back mapping, model courses, sample instructional and workplace tasks
- Achieve Advocacy Tools—Math at Work Brochures and other advocacy tools making the case for advanced mathematics for ALL students www.achieve.org/mathatwork

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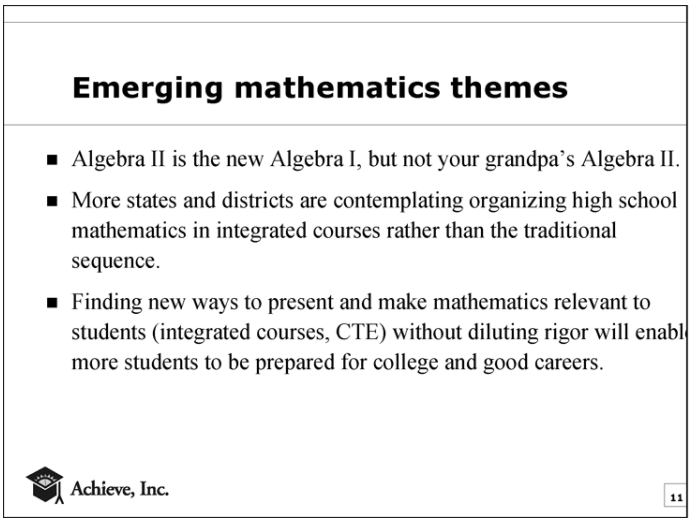

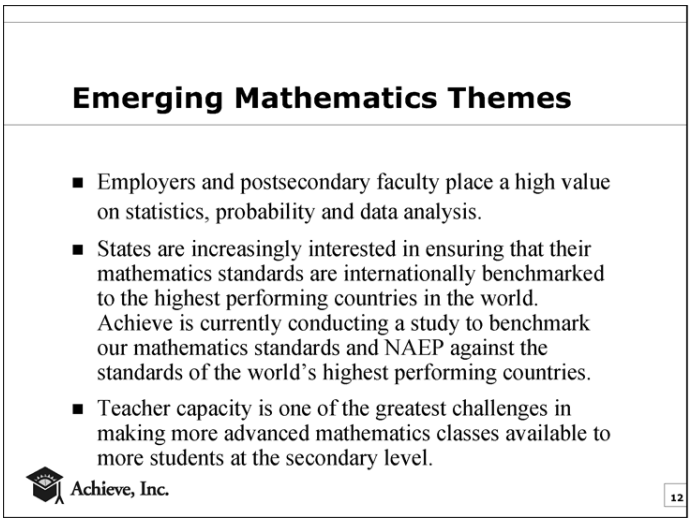

Chairman MILLER. Thank you.
Dr. Haver?

STATEMENT OF WILLIAM HAVER, PROFESSOR OF MATHEMATICS, VIRGINIA COMMONWEALTH UNIVERSITY

Mr. HAVER. We really can increase the number of students that are successful in mathematics. It can happen. A growing number of elementary schools in Virginia are using mathematics specialists as a powerful tool to enable more students to be successful.

As defined in Virginia, mathematics specialists are responsible for strengthening teachers' understanding of mathematics and helping teachers develop more effective teaching practices through co-planning, co-teaching, and coaching. Specialists are helping

teachers and schools develop strong programs consistent with the findings of the National Math Panel.

They help implement a school-wide curriculum. They assure that students develop conceptual understanding, computational skills, and problem-solving. It is not either-or. It is all three. They provide professional development to increase the teacher's knowledge of mathematics and of effective research-based teaching strategies.

The first full-time coaches were placed in Virginia about 10 years ago. The mathematics supervisors, principals and teachers reported on the major differences that the specialists made in the schools. There were major improvements reported in student performance on standardized tests.

In about 2003, there was a consensus around the state in the mathematics community that, one, we should develop the capacity to have mathematics specialists prepared and put in place statewide in Virginia, and secondly, that we should concurrently conduct high-quality research of the type called for by the National Math Panel to measure the impact of specialists.

Many organizations have worked together in the state to do this. The Virginia Mathematics and Science Coalition, with critical support from ExxonMobil; the Virginia Council of Teachers of Mathematics and the Council of Mathematics Supervisors; six universities that worked together collaboratively to develop and offer master's degree programs designed for math specialists; the Virginia Board of Education that approved a math specialists endorsement; the state legislature that has appropriated funds to partially support the research program I will describe in a minute; the Virginia Department of Education, which has strongly supported math specialists, including directing funds from the United States Department of Education's Mathematics and Science Partnership Program to help prepare mathematics specialists in Virginia.

So as a result of this capacity building, there are currently approximately 300 school-based mathematic specialist coaches in Virginia. So concurrent to this decision that we made in 2003 to work on the preparation programs for the math specialists and the support provided for them, we made a decision to undertake detailed scientific research on math specialists. We are in the middle of that research program.

Even today, as pointed out by the National Math Panel, there is no public research with treatment and control groups that say anything about the impact of math specialists. The research that is known is knowing what good practices are and that math specialists do this, but as far as research directly demonstrating the impact of math specialists, that doesn't exist.

So we were awarded two grants from the National Science Foundation to help us put these programs in place that I described, and to determine the impact of mathematics specialists. The one key component of the research, and I will just stick to this one component, centers on 12 triples of schools. So each set of three schools was identified by a school system as being comparable to each other. One school from each triple was randomly chosen by the researcher to have a math specialist, and a second school was randomly chosen from each set of three schools to have a math specialist 2 years later.

So therefore, with this treatment control basis, we are beginning to obtain preliminary results on the mathematics specialists on mathematics achievement scores. When compared with students in the control schools, students in schools with mathematics specialists performed better on our statewide high-test stakes in each of the grades where the tests are given, in grades three, four and five.

Indeed, in each grade, their performance was better in each subcategory—numbers, computation and estimation, patterns, functions in algebra. The greatest difference was observed in grade four, where the positive effect of having a coach in the school was approximately 80 percent of the magnitude of the negative effect of poverty. We know that students in poverty score lower on the tests like this, and the impact of having a math specialist in the school was 80 percent of the magnitude of that. It was 52 percent in grade three and 47 percent in grade five.

The school superintendents of the systems that are participating in this study were interviewed last summer by our policy research team. According to the report, they were unanimous in their confidence about the effectiveness of in-school coaching models and their desire to implement it in all elementary and middle schools. We believe that this is a real opportunity, a real tool to bring about significant change across the board.

[The statement of Mr. Haver follows:]

Prepared Statement of Dr. William Haver, Professor of Mathematics, Virginia Commonwealth University

A growing number of elementary schools in Virginia have been making extensive use of Mathematics Specialists as a tool to enable many more students to be successful in learning mathematics.

As we use the term in Virginia, a Mathematics Specialist is based in an elementary school in order to support the professional growth of teachers and promote excellent mathematics instruction and student learning. Mathematics Specialists are responsible for strengthening classroom teachers' understanding of mathematics content and helping teachers develop more effective mathematics teaching practices. Typically they collaborate with individual teachers through co-planning, co-teaching, and coaching. The duties of these Mathematics Specialists are described in more detail in the appendix to the materials submitted to the committee entitled Who are Mathematics Specialists?

Working in a school building the Mathematics Specialists are helping teachers and schools develop strong programs consistent with the findings and recommendations of the National Math Panel. They

- Implement a school-wide curriculum that is focused and provides coherent progression from year to year.
- Assure that students develop both conceptual understanding and computational fluency.
- Provide professional development so that:
- Teachers know in detail and from a more advanced perspective the mathematics content they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach.
- Teachers are aware of and can implement effective research-based teaching strategies.

Virginia first began utilizing Lead Mathematics Teachers in the early 1990s. Based on what was learned about the accomplishments and limitations of classroom teachers serving as lead mathematics teachers, the mathematics community studied the use of Mathematics Specialists in other states.

The first full-time, school-based coaches were placed in Virginia schools about ten years ago. The impact of these Specialists on instructional practice and student achievement was marked. Mathematics supervisors, principals and teachers reported on the major difference that the Specialists made in teachers' attitudes and approaches to teaching mathematics. Major improvements in student performance

on standardized tests were reported. For example, in one school system with three elementary schools a full-time coach was employed in one school; a year later, that school became fully accredited for the first time. This process was repeated each year for the next two years in the division's other two elementary schools. In a larger inner city system that made use of Mathematics Specialists, student achievement increased so that no elementary schools were "unaccredited" or "accredited with warning in mathematics." As a result of these gains the district decided in 2004 to employ coaches in all 35 elementary schools. A special issue, volume 8, of the Journal of Mathematics and Science: Collaborative Explorations was published, with support from ExxonMobil, detailing these and other (admittedly anecdotal) experiences. The issue is available on-line on the Virginia Mathematics and Science Coalition home page *http://www.vamsc.org/*.

As this strong and striking evidence became available in 2002-03 consensus developed in all components of the mathematics/mathematics education community that

I. The capacity should be developed statewide to appropriately prepare teachers to serve as Mathematics Specialists as resources become available and as school systems make the decision to deploy Specialists.

II. Concurrently conduct high-quality research of the type called for by the National Mathematics Advisory Panel to measure the impact of the preparation program on prospective Mathematics Specialists and the impact of Specialists on teachers they support and on student achievement.

I. Building Capacity

The Virginia Mathematics and Science Coalition identified Mathematics Specialists as the most promising means to improve student achievement in grades k-12. The Coalition appointed a statewide Task Force to develop a consensus on the role of Specialists, the recommended competencies and the preparation program. Critical financial and advisory support has been provided by ExxonMobil.

The Virginia Council of Teachers of Mathematics and the Virginia Council of Mathematics Supervisors both developed and implemented programs to support Mathematics Specialists.

Six universities collaboratively developed and are offering especially designed masters degree programs for Mathematics Specialists. The partners include: Virginia Commonwealth University (VCU), Norfolk State University (NSU), University of Virginia (UVA), Longwood University (LU), George Mason University (GMU), and Virginia Tech (VT). To date approximately 95 degrees have been awarded and 150 teachers are enrolled in degree programs.

The Virginia Board of Education with the concurrence of the governor has approved a Mathematics Specialist endorsement. The Board has also recommended to the State legislature that school systems be required to deploy a Mathematics Specialist for each 1,000 students in grades k-8.

The State legislature has supported the concept of Mathematics Specialists. While not acting on the recommendation to require systems to deploy Specialists, the legislature has appropriated funds to partially support the research program described below.

The Virginia Department of Education has strongly supported Mathematics Specialists at all stages, including using funds from the United States Department of Education Mathematics and Science Partnership program to prepare Mathematics Specialists. The department also provided access to student scores on standardized tests in support of the research described below.

As a result of this capacity building there are approximately 300 school-based Mathematics Specialists in Virginia.

II. Research

Concurrently, in 2003, the decision was made to seek support to undertake detailed scientific research on Mathematics Specialists. At this time there was interesting, high quality research demonstrating the effectiveness of teachers having the knowledge and skills that Mathematics Specialist programs are designed to develop, but no research with treatment and control groups directly demonstrating the impact of Mathematics Specialists on student learning. As pointed out in the National Mathematics Advisory Panel reports no such results are published to date.

In order to conduct this research and to develop the preparation programs described earlier we submitted competitive proposals to the National Science Foundation. We were successful in this competition and were awarded grants to determine the impact of preparation programs on Mathematics Specialists and the impact of Mathematics Specialists on the teachers they support and on student learning. The awards were made in the summer of 2004. Since then we have developed and re-

fined the preparation programs, offered the programs to prospective Mathematics Specialists, placed Specialists in schools, and conducted the planned research.

One key component of the research centers on 12 triples of schools. Each set of three schools were identified by a participating school system as being comparable demographically and having similar test scores. One school from each triple was randomly chosen and a Mathematics Specialist who had completed the preparation program was placed in each of these Cohort I schools beginning in August 2005; a second school (Cohort II) was randomly selected from each triple and a specialist was placed in each of these schools beginning in August 2007. No Specialists will be assigned to the third school in each triple throughout the duration of the research project. Detailed information is being analyzed concerning the beliefs of teachers and the academic achievement of students in the treatment and control schools. As a part of the research program, each research subject records what she or he is doing during each period of time by entering data in a PDA. For example, the researcher knows how much time each teacher in the building is being supported by the Specialist.

We are beginning to obtain preliminary results on the Mathematics Specialists' impact on student mathematics achievement scores as measured by SOL tests in Virginia. To assess this, the analysis has accessed data on approximately 6,400 student test scores in each of Grades 3, 4, and 5 from 36 schools over 2 years. Thus, the analysis of 19,407 students SOL scores was done. When compared with students in the control schools, students in schools with Mathematics Specialists performed better on the SOL Mathematics test in each of grades 3, 4 and 5. Indeed, in each grade their performance was better in each subcategory: Number, Number Sense, Computation, Estimation, Measurement, Geometry, Probability and Statistics, and Patterns, Functions, and Algebra.

The greatest difference was observed in grade 4 where the differences were statistically significant and where SOL tests have been most recently introduced. The positive effect of having a coach in the school is approximately

- 87% of the magnitude of the negative effect of limited English proficiency,
- 80% of the magnitude of the negative effect of poverty,
- 43% of the magnitude of the negative effect associated with minority student status on fourth-grade SOL performance.

In grade 3 the results were not statistically significant, but the positive effect was

- 85% of the magnitude of the negative effect of limited English proficiency,
- 52% of the magnitude of the negative effect of poverty,
- 27% of the magnitude of the negative effect associated with minority student status on third-grade SOL performance.

In grade 5 the results were not statistically significant, but the positive effect was

- 42% of the magnitude of the negative effect of limited English proficiency,
- 47% of the magnitude of the negative effect of poverty,
- 31% of the magnitude of the negative effect associated with minority student status on fifth-grade SOL performance.

This analysis has not yet investigated what kinds of activities the Specialists engaged in with particular teachers, nor has it investigated the expected variability in degree and time of support afforded by the Specialists to differing teachers. Inclusion of these data will better specify not only the level of involvement and therefore potential impact of Specialists with individual teachers, but will also characterize more accurately the degree of treatment afforded to teachers associated with the nested student SOL data.

Because this preliminary analysis of student SOL data has not accessed teacher—specialist data as collected through the PDAs, the current analysis presumes that the impact of a specialist is identical for all teachers and all students in each given grade within a school. This is not the case. From day to day the Specialists vary in terms of the professional development services and instructional support that they engage in and in terms of the teachers with whom they work. It is anticipated that future analysis accessing teacher-level data will be more precise, as this preliminary analysis of the school-level effect of Specialists on student achievement has averaged the teacher effect across all teachers in the schools.

School superintendents of the school systems that are participating in the research were interviewed at the conclusion of the 2006-07 school year. At this point one school in each triple had been assigned a Mathematics Specialist and two had not. According to the report, "they were unanimous in their confidence about the effectiveness of the grant's in-school coaching model and their desire to implement it in all elementary and middle schools."

APPENDIX

Who Are Mathematics Specialists?

Mathematics Specialists are teacher leaders with strong preparation and background in mathematics content, instructional strategies, and school leadership. Based in elementary and middle schools, mathematics specialists are former classroom teachers who are responsible for supporting the professional growth of their colleagues and promoting enhanced mathematics instruction and student learning throughout their schools. They are responsible for strengthening classroom teachers' understanding of mathematics content, and helping teachers develop more effective mathematics teaching practices that allow all students to reach high standards as well as sharing research addressing how students learn mathematics.

The overarching purpose for Mathematics Specialists is to increase the mathematics achievement of all the students in their schools. To do so, they

- Collaborate with individual teachers through co-planning, co-teaching, and coaching;
- Assist administrative and instructional staff in interpreting data and designing approaches to improve student achievement and instruction;
- Ensure that the school curriculum is aligned with state and national standards and their school division's mathematics curriculum;
- Promote teachers' delivery and understanding of the school curriculum through collaborative long-range and short-range planning;
- Facilitate teachers' use of successful, research-based instructional strategies, including differentiated instruction for diverse learners such as those with limited English proficiency or disabilities;
- Work with parent/guardians and community leaders to foster continuing home/school/community partnerships focused on students' learning of mathematics; and
- Collaborate with administrators to provide leadership and vision for a schoolwide mathematics program.

Chairman MILLER. Thank you.

Dr. Staggers?

STATEMENT OF WANDA T. STAGGERS, MASTER TEACHER AND DEAN OF MANUFACTURING AND ENGINEERING, ACADEMY OF ENGINEERING AND BIOMEDICAL SCIENCES

Ms. STAGGERS. Chairman Miller, Ranking Member McKeon, and members of the committee, thank you for the opportunity to present before the House of Representatives' Committee on Education and Labor.

During my professional career, I have taught in the fields of mathematics, computer science, and engineering both on the secondary and post-secondary levels. Mathematics came alive for me when I began teaching applied courses in computer science and engineering. Mathematics education then surpassed the normal tasks of completing textbook problems and I was presented with real-world applications—applications with results both predictable and unpredictable.

In 2002, I became a Project Lead the Way master teacher in the course Principles of Engineering. The following year, I became a master teacher in a second course, Computer Integrated Manufacturing. Project Lead The Way helps give middle and high school students the rigorous coursework they need to develop strong backgrounds in science and engineering.

The National Mathematics Advisory Panel's report and recommendations relative to professional development are congruent with the Project Lead The Way model in a number of ways. Project Lead The Way rejects what has become commonplace in the teaching profession—cursory weekend workshops that get educators ex-

cited temporarily, but do not actually change what goes on in the classroom.

This model embodies the panel's emphasis on content and relevance and includes ongoing support for school counselors, administrators, and their technical support staff—no more "drive by" professional development that leaves the teachers and the students short-changed and frustrated.

An essential criterion for achieving effective professional development is the appropriate alignment of the teacher's skills with the professional development training objectives. The National Mathematics Advisory Panel suggests, "Schools and teacher education programs should develop or draw on a variety of carefully evaluated methods to attract and prepare teacher candidates who are mathematically knowledgeable and to equip them with the skills to help students learn mathematics."

To determine the teacher's ability to meet the objectives of the training experience and to assist teachers in academic preparation prior to the training experience, a pre-assessment measure should be used. As a result, teachers know more about what they are teaching and how to teach it.

A second criterion for effective professional development is active participation. This model provides teachers with 2 weeks of intense hands-on training. Teachers experience the curriculum and instruction in the same way their students will in the classroom. The lessons allow opportunities for cross-discipline instruction with both technology and other academic subject areas. The curriculum requires the application of science, technology, engineering, and mathematics. Cross-discipline instruction increases student comprehension and retention, and answers the question so often asked by students: Why do I need to know this?

I would like to share one example of the impact that cross-discipline instruction has had on my classroom. After a challenging lesson in truss calculations, Dhaval told one of his classmates that he planned to hug his math teacher when he saw her the next time. I asked him why. He said had it not been for the effective instruction in his algebra II course, he would have been lost in the lesson that I had just delivered.

He went on to say that when he was involved in the math course, he had no understanding of why he was doing what he was doing. It wasn't until he enrolled in the Project Lead The Way classes that he knew how to apply what he had learned.

A third criterion for effective professional development is a modern, flexible support system that is readily accessible and accommodates different learning styles. The Project Lead The Way model provides an online Virtual Academy that is available to teachers upon demand and offers numerous lessons in middle school and high school curricula.

The Project Lead The Way ListServ is available to teachers as a resource for technical assistance and as a forum to share ideas for advanced applications and tap into the expertise from their peers. Teachers can post questions on the ListServ and will most likely receive a solution within 15 minutes from another teacher anywhere in the country. This system encourages camaraderie and

fosters a professional environment that is often lacking in other professional development models.

After 6 years of training high school teachers during Project Lead The Way summer training institutes, I have heard overwhelmingly from teachers that they come away from the experience with a rejuvenated interest in teaching. After returning to the classroom, teachers report that they felt more confident in the use of technology and better informed on current issues in science, engineering, and mathematics.

Many school districts decline to offer technology programs due to the high cost of equipment, but in reality technology programs provide real applications for mathematics and science, while preparing the student for the workforce or post-secondary education.

As you and your colleagues consider education policy, I hope you consider the recommendations of the Math Panel with regard to professional development. As my experience with Project Lead The Way shows, the ideas and concepts are sound and should be elements of any professional development effort, federal or otherwise.

I would just like to add one last thing. I have a student who built a model of an airplane in the classroom. He used algebra, geometry, trigonometry, auto-desk inventor software, education software, and the CNC mill to build that airplane out of 18 individual parts. That was an application of everything he learned in his 11 years of school.

Thank you for the opportunity to present, and I look forward to answering any questions you may have.

[The statement of Ms. Staggers follows:]

Prepared Statement of Dr. Wanda Talley Staggers, Dean of Manufacturing and Engineering, Anderson School District Five

Chairman Miller, Ranking Member McKeon and Members of the Committee, thank you for the opportunity to present before the House of Representatives Committee on Education and Labor.

During my professional career, I have taught in the fields of mathematics, computer science, and engineering both on the secondary and post-secondary levels. Mathematics came alive for me when I began teaching applied courses in computer science and engineering. Mathematics education then surpassed the normal tasks of completing textbook problems and I was presented with real-world applications—applications with results both predictable and unpredictable. I am currently I enrolled in the General Engineering Technology Associate degree program at Tri-County Technical College in Pendleton, South Carolina so that I can be better prepared in the field of engineering. I want to create an environment that emphasizes critical thinking skills, helps students make logical connections, and instills the desire and excitement to learn more about science, technology, engineering, and mathematics and how it affects our world.

The History of Project Lead The Way™

In 2002, I became a Project Lead The Way™ master teacher in the course Principles of Engineering. The following year, I became a master teacher in a second course, Computer Integrated Manufacturing. Project Lead The Way™ helps give middle and high school students the rigorous coursework they need to develop strong backgrounds in science and engineering.

The National Mathematics Advisory Panel's report and recommendations relative to professional development are congruent with the Project Lead The Way model in a number of ways. Project Lead The Way™ rejects what has become commonplace in the teaching profession—cursory weekend workshops that get educators excited temporarily, do not actually change what happens in the classroom. This model embodies the panel's emphasis on content and relevance and includes ongoing support for school counselors, administrators, and their technical support staff. No more "drive by" professional development that leaves the teacher, the school and the students short-changed and frustrated.

Project Lead The Way™ Three Phase Professional Development

An essential criterion in achieving effective professional development is the appropriate alignment of the teacher's skills with the professional development training objectives. The National Mathematics Advisory Panel suggests, "Schools and teacher education programs should develop or draw on a variety of carefully evaluated methods to attract and prepare teacher candidates who are mathematically knowledgeable and to equip them with the skills to help students learn mathematics." To determine the teacher's ability to meet the objectives of the training experience and to assist teachers in academic preparation prior to the training experience, a preassessment measure is used. As a result, teachers know more about what they are teaching and how to teach it.

A second criterion for effective professional development is active participation. This model provides teachers with two weeks of intense hands-on training. Teachers experience the curriculum and instruction in the same way their students will in the classroom. The lessons allow opportunities for cross-discipline instruction with both technology and other academic subject areas. The curriculum requires the application of science, technology, engineering, and mathematics. Cross-discipline instruction increases student comprehension and retention, and answers the question so often asked by students, "Why do I need to know this?"

I would like to share one example of the impact that cross-discipline instruction has had on my classroom. After a challenging lesson in truss calculations, Dhaval told his classmates he planned to hug his math teacher the next time they crossed paths. Slightly confused, I asked him why. He replied that had it not been for his math teacher's effective instruction in his Algebra 2 course, he would have been lost in the truss calculation lesson that I had given. Dhaval went on to say that while he was in the math course, he failed to see relevance for the material learned but since enrolling in the Project Lead The Way™ courses, he has applied the mathematical procedures to solve many problems.

A third criterion for effective professional development is a modern, flexible support system that is readily accessible and accommodates different learning styles. The Project Lead The Way™ model provides an online Virtual Academy that is available to teachers upon demand and offers numerous lessons in middle school and high school curricula. The Project Lead The Way™ ListServ is available to teachers as a resource for technical assistance and as a forum to share ideas for advanced applications and tap into the expertise from their peers. Teachers can post questions on the listserv and will most likely receive a solution from another teacher, who could be from any where in the country, within 15 minutes. This system encourages camaraderie and fosters a professional environment that is often lacking in other professional development models.

South Carolina and other states offer Project Lead The Way™ ongoing professional development during the fall and spring of the academic year. Through partnership agreements with Piedmont Technical College and Orangeburg-Calhoun Technical College, teachers receive additional professional training from statewide master teachers. The college partners provide equipment and materials. Teachers work together in small groups, assist one another in weak areas, and share best practices. Once again, the professional development is specifically aligned with the needs and interests of the teachers and the curriculum they teach. Technical support is also available for hardware and software challenges. These ongoing training and partnership agreements are organized through the South Carolina State Department of Education.

Finally, the certified Project Lead The Way™ schools are subject to a certification process that involves the state university partner and the State Department of Education. This certification process occurs every five years and ensures that the schools deliver the curriculum to the standards established by Project Lead the Way. One of the criteria for Master Teacher status is that the teacher must teach at a Project Lead The Way™ certified school. Only Project Lead The Way™ certified schools may administer the college credit portion of the end-of-course assessments to qualified students. Students scoring successfully on the national Project Lead The Way™ end-of-course college examination may apply for college credit at more than 30 four-year institutions across the nation and at an even larger number of two-year institutions.

In Closing

After six years of training high school teachers during the Project Lead The Way™ Summer Training Institutes across the nation, I have heard overwhelmingly from teachers that they come away from the experience with a rejuvenated interest in teaching. After returning to the classroom, teachers reported that they felt more

confident in the use of technology and better informed on current issues in science, technology, engineering, and mathematics.

The National Mathematics Advisory Panel recommends, "* * * teachers must be given ample opportunities to learn mathematics for teaching." I couldn't agree more. A well-prepared teacher must be given the tools, technology, and time to advance in their field. That is, teachers must understand in detail and from a more advanced perspective the mathematical content they are responsible for teaching and the connections of that content to other relevant disciplines. But it is important to note that even the best teacher preparation cannot overcome poor leadership and inadequate administrative support.

Many school districts decline to offer technology programs due to the high cost of equipment but in reality, technology programs provide real applications for mathematics and science while preparing the student for the workforce or post-secondary education. Because of funding issues, inequities in school programs exist across the nation, across the state, and even within the same city. Graduates from these schools compete in the same classroom at local colleges and state universities. I am fortunate to be employed by a district that recognizes the importance of professional development, the impact that technology has on education, and the impact of both on student achievement.

As you and your colleagues consider education policy, I hope you consider the recommendations of the Math Panel with regard to Professional Development. As my experience with Project Lead They Way shows, the ideas and concepts are sound and should be elements of any professional development effort, federal or otherwise.

Thank you again for this opportunity, and I look forward to answering any questions you might have.

Chairman MILLER. Thank you very much, Dr. Staggers.

Dr. Wolf, I think she set you up for your testimony here.

Ms. WOLF. I know. Isn't that nice? Thank you. [Laughter.]

Chairman MILLER. You guys worked out this segue here.

STATEMENT OF MARY ANN WOLF, EXECUTIVE DIRECTOR, STATE EDUCATION TECHNOLOGY DIRECTORS ASSOCIATION

Ms. WOLF. Good morning. Thank you, Chairman Miller, Representative McKeon and the committee for inviting me to testify today.

I would like to also especially thank Representative Hinojosa and Representative Biggert for being the lead cosponsors on the Achievement Through Technology and Innovation, or the ATTAIN Act.

I am Mary Ann Wolf with SETDA, which represents the education technology leaders and the SEAs in all 50 states. Our members agree wholeheartedly with the National Math Panel report on the need and the potential to improve math education.

I would now like to take you to a small school district in Floydada, Texas, where the median household income is $27,000 and only about 57 percent of the population has a high school degree. You can imagine that with these demographics, many students have very limited experience and a narrow vision for their education.

This school district made strategic decisions to change learning for kids forever by providing access to technology tools and resources, through relevant instruction being taught by teachers who had ongoing and sustainable professional development. I will tell you, it transformed Floydada.

Imagine the student who never understood why algebra mattered, and introduce a lesson that asked him to figure out how much the rising gas prices affected his family. Technology, including collaboration on the interactive white boards, graphing and

modeling formulas to learn algorithms, and visually mapping out the problem contributes to a deeper learning in these math skills and connects to 21st century learning.

Suddenly, Algebra I, often cited as the gateway to graduation, is relevant. Tenth grade math scores in Floydada on the state exam went up by 36 percent, and sixth grade math scores went up by 29 percent. This took a comprehensive approach that affected all stakeholders, but it is possible. It was part of a bigger state initiative called the Technology Immersion Pilot, which focuses on using technology for systemic reform. This is critical as we consider what we can do to address the teaching and learning of math.

The students in kindergarten this year will graduate in 2020. At some point, all kids come to us wanting to learn, even math, and we just lose them sometime along the way. I think this is our responsibility and our opportunity.

SEDTA worked with the Partnership for 21st Century Skills, ISTE, and many stakeholders to address what America needs to be competitive. In the maximizing-the-impact book, the pivotal role of technology in a 21st century education, we concluded that in a digital world, no organization can achieve results without incorporating technology into every aspect of its everyday practices. It is time for schools to maximize that impactive technology as well. This is especially true for mathematics.

In Vallejo, California, the sixth-and seventh-grade math teachers received ongoing sustainable professional development to integrate technology into the classroom. Teachers learned to use new models for teaching the content in a more effective way. Vallejo focused on the lowest-performing students. In one lesson, students were involved in a game show class quiz format for content review, but teachers received immediate feedback to individualize instruction to reach those students previously unsuccessful. The district has seen large gains on state math test scores and approximately 40 percent of those students moved up an entire performance band in the first year.

Similar to the Texas TIP program in Floydada, Utah, Missouri and Maine have implemented the eMINTS program, which provides classrooms and schools with technology tools, curriculum and over 200 hours of professional development. These students are able to reach the NCLB goals and 21st century skills.

In Utah, where eMINTS and control classrooms existed in the same school, eMINTS students repeatedly achieved over 10 percent higher on state exams. In Missouri, after 6 years of looking at fourth grade math data, eMINTS students in special education, low-income, entitlement sub-groups have reduced the achievement gap in test scores between the performance of their peers by one-half. The achievement gap is closing.

As has been mentioned very effectively, there is a tremendous opportunity with technology to make professional development ongoing and systemic. Programs like ACCESS in Alabama, IDEA in Arizona, and eLearning Delaware lead to changes in teaching and learning. Virginia has also implemented instructional technology coaches.

Technology is also very important for formative assessment. The Philadelphia public schools implemented an instructional manage-

ment system to frequently assess individual student achievement, which has contributed to the increase in AYP schools from 58 to 132 schools over 2 years, and math achievement went up by 14 percent. Again, knowing what kids know and what they need to know makes a big difference.

The good news is that we have many strong examples in written testimony. The bad news is that a Department of Commerce study determined that out of 55 industries, education was dead last in the use of technology. Now is the time to maximize technology for all kids.

We appreciate the committee's support through the EETT Program, NCLB, and the ATTAIN Act and the draft reauthorization of ESEA. The ATTAIN Act builds upon the data that is shared today, and focuses on systemic and strategic approaches to technology. ATTAIN will serve as a catalyst for more students to have a 21st century education system.

To conclude, federal leadership must be bold to help transform how we teach, learn and apply math for our competitiveness and innovation. This is possible even for high-need kids like in Floydada, but it will take a concerted effort by you, by the states, by district, and by all stakeholders and educators.

We ask that you specifically recognize the important role of technology in all education legislation. We can't afford to miss this opportunity that technology provides to engage students, to improve instruction and teacher quality, and to ultimately raise student achievement in math so that our students are prepared for the 21st century.

Thank you.

[The statement of Ms. Wolf follows:]

Prepared Statement of Mary Ann Wolf, Ph.D., Executive Director, State Educational Technology Directors Association (SETDA)

Good Morning. Thank you to Chairman Miller, Representative McKeon, and the Committee for inviting me to testify today. I would like to especially thank Representative Hinojosa and Representative Biggert for sponsoring the Achievement through Technology and Innovation (ATTAIN) Act. I am Mary Ann Wolf with SETDA, the State Educational Technology Directors Association. Our organization represents the educational technology leaders in the SEAs in all 50 states, Washington, DC, and American Samoa. Our members tackle issues ranging from using data to inform and individualize instruction for each child, providing the technology tools necessary to modernize our schools and engage the 21st Century learner, as well as providing innovative approaches to envision a "new norm" for America's students. Our members agree wholeheartedly with the National Mathematics Advisory Panel Report on the need to improve math education in this country.

As we consider America's and our students' competitiveness and the continued discouraging graduation rates, we are encouraged by the evidence we have about programs that make a difference for our students. The examples and data below address the following areas:

- Maximizing the Impact: The Pivotal Role of Technology in a 21st Century Education System
- Teaching and Learning Math: Improving Student Achievement and Increasing Student Engagement
- Professional Development: Training That Changes Practice and Instruction
- Formative Assessment: Using Real Time, On-going Data to Individualize Instruction

Maximizing the Impact: The Pivotal Role of Technology in a 21st Century Education System

As we look to America's future, we must also reflect on the present. Only 7% of U.S. college students currently major in math or science fields, and this number de-

creases to 3% by the end of the first year of college. More than 57% of our post-doctoral engineering students are from outside of the U.S., and U.S. Patent applications from the Asian countries grew by 759 % from 1989 to 2001. Patent applications from the U.S. during the same period grew at 116 %. High-speed global networks enable nearly instantaneous communication, collaboration and knowledge sharing which gives our competitors more advantages than they had in the past. Any approach to our challenge of educating America's youth must rely on technology solutions that are scalable, flexible, reliable, and have the ability to cost-effectively individualize education for all students. The opportunity cost for not addressing this challenge and improving math learning is too high, and education stakeholders must be bold and specific in efforts to improve math achievement.

As identified in the SETDA Math Toolkit, the use of technology can support the teaching and learning of mathematics by bringing a multitude of learning experiences to captivate student interest and build mathematics understanding, proficiency, application and confidence. Mathematical understanding is increased when students and teachers use and apply technology to investigate mathematical concepts; including visualization, modeling, representation, simulation and communication. Students learn mathematics in different ways, and we need to provide technology, resources, varied instructional strategies and skills that allow them to excel, deepen their understanding and maximize their potential. Students build mathematical knowledge and understanding of mathematical concepts through problem solving. Educational technology strengthens the connection of mathematical topics in different contexts. (2007, www.setda.org)

The students in Kindergarten this year will graduate in 2020. In some schools, in some districts, in some states, students are receiving an education that can be identified as meeting the needs of the 21st Century students. It is our responsibility to ensure America is maximizing its potential, both in closing the achievement gap and addressing the needs of high achieving students who will be our nation's next innovators. NCLB provides us with accountability goals for our students, districts, and states; but as we look at the big picture around America's and our students' competitiveness, it often seems that how the majority of schools have responded to NCLB directly contradicts what we know about ensuring that our students are prepared for the 21st Century global economy. I would argue that this does not need to be the case. Technology can help address core content achievement and 21st Century Skills for children of all abilities and achievement levels.

When we talk about technology, we are not talking about putting some computers in the back of a classroom—we are talking about utilizing the power of technology to change the way teachers teach and children learn. While many of you cannot imagine your workday without technology to access resources or communicate, this is still not the case for many students and teachers on a typical school day.

Unfortunately, we cannot assume that technology has been maximized in most schools—a Department of Commerce study shared that education was actually 55th out of 55 industries studied in use of technology. The education community needs to invest in technology and embrace its uses just as the business community transformed its practices throughout the last 20 years. Again, technology will only be maximized when it is used for practical and contextual solutions such as individualizing instruction, engaging students, and providing access to rigorous and dynamic content for teachers, students and parents. When technology is used only for supplemental instruction, it cannot act as the transformational force helping us ready our children for the 21st century workforce.

SETDA recently worked with the Partnership for 21st Century Skills, the International Society for Technology in Education (ISTE), and a broad cross-section of business and philanthropic stakeholders in education, including Apple, Cisco, ENA, the Oracle Foundation, and the Pearson Foundation, to address the important question: "How will we create the schools America needs to remain competitive?" Maximizing the Impact: the Pivotal Role of Technology in a 21st Century Education System provides a blueprint and examples on how technology makes a difference in teaching and learning.

For more than a generation, the nation has engaged in a monumental effort to improve student achievement. We've made progress, but we're not even close to where we need to be. It's time to focus on what students need to learn—and on how to create a 21st century education system that delivers results. In a digital world, no organization can achieve results without incorporating technology into every aspect of its everyday practices. It's time for schools to maximize the impact of technology as well. (Maximizing the Impact, 2007 found at *http://www.setda.org/web/guest/maximizingimpactreport.)*

This is especially true for mathematics. Students should have a strong understanding of mathematical knowledge and skills, and the ability to apply it in rel-

evant problem solving situations using inquiry and investigation, collaboration, and critical thinking skills. STEM education should be for ALL students—not just the cream of the crop who has access to the magnet option. STEM education is interdisciplinary providing context around math, science and engineering to engage students who will thrive and become competitive leaders in the global economy.

Educators should have a deep understanding of mathematical concepts and their applications to relevant problem solving situations, and should continue to gain insight and understanding of strategies and methods to encourage their students to learn, use and be intrigued by mathematics. Math teachers should work in cadres inside the school or utilize technology to collaborate with like-subject teachers in other schools for peer-to-peer professional development and collaboration to hone pedagogical approaches as well as specific content knowledge in the subject. STEM teams can also collaborate using this method to provide powerful learning opportunities for teachers and students. Technology helps accomplish these goals.

It is our responsibility to ensure that our children are prepared to lead our country in the 21st century, which includes a deep understanding and usage of math and its core concepts. The role of technology to transform education into a system that can achieve this goal must be at the forefront. We must rely on technology solutions that are scalable, flexible, reliable, and have the ability to cost-effectively individualize education for ALL students.

Teaching and Learning Math: Improving Student Achievement and Increasing Student Engagement

We are beginning to know what makes a difference in teaching and learning math. The same practices and instructional methods that affect student engagement and achievement in math increase student achievement in other areas as well. The development of programs that include key tools, rigorous and dynamic resources, leadership, and professional development are proving to have real, significant impact as evidenced through research funded by the US Department of Education. The systemic reform models shared below lead to increases in mathematics achievement and have many commonalities. In all cases teachers had the technology tools and resources to utilize in planning and in instruction, and teachers received extensive on-going and sustainable professional development. In math instruction, these strategies included collaborative learning, relevant projects and content, using tools and resources to address various learning styles, and problem solving, in addition to learning facts. Professional development to change instructional strategies was critical to the transformation of teaching and learning.

• California: In the 6th and 7th grades in Franklin Middle, Solano Middle, Springstowne Middle, and Vallejo Middle Schools, math teachers are trained to integrate technology into the classroom, they saw how the technology could be used to hit key points, engage students, use modern tools in ways they had never tried. When teachers learned new strategies, it strengthened their teaching with technology, but it also energized their overall teaching as they applied the strategies to other areas. Teachers, who have taught math for many years, learned and used new models for teaching the content in a more effective way. These teachers would not have shifted without the impetus of this program. Results include:

• Formative Assessment, Gaming & Accountability: Vallejo focused on the lowest performing students in 6th and 7th grade. Typically, these students don't engage in the learning environment. Since the program uses different types of technology in the classroom, there are multiple opportunities to engage the students. Students loved using technology in a game show/class quiz format for content review. What they didn't realize was that the instant feedback strengthened the teaching and provided data to individualize instruction.

• Differentiated Instruction & Just in Timing Learning: PowerPoint presentations were used in many classes. Because of the high absentee rate at the schools, students could review the presentations that they missed to get caught up with the class. The math program uses technology to explore and develop concepts and then reinforce skills. Most importantly, this transition from concepts to skills was on pace with the learners abilities. By differentiating the instruction with technology, teachers are able to reach previously unsuccessful students.

• Increased Student Achievement: The district saw large gains on CST scores for the target students, the 50 lowest-performing students in each middle school. Approximately 40% moved up one performance band in the first year. The two-year objective was met in the first year.

• North Carolina: In North Carolina, several high poverty elementary and middle schools implemented the IMPACT systemic reform program. The model involves using technology in the teaching of core curricular areas to improve student achievement, utilizing technology coaches and school library media specialists for on-going

professional development, as well as learning 21st Century Skills. In these schools, teachers use technology to differentiate instruction based on formative assessment, utilize technology to engage students with various learning styles, and provide curricular options for students based on achievement. Students collaborate, apply knowledge to real-world problems, and receive repetition and enrichment as needed. For more information, go to: *http://www.ncwiseowl.org/Impact/*. Findings include:

- In a four year study, students in the high need schools with the IMPACT program have demonstrated that they are 33% more likely to improve one full grade level each year than the control/comparison schools.
- Teacher retention is 65% higher with this program.
- In Math specifically, the odds that IMPACT students would go from non-passing to passing status over the three years were 42% higher than that for comparison students.
- In the fourth year, the odds of IMPACT students passing the Math end of grade tests were 24% higher than that of comparison students. This effect was stronger in earlier grades.
- Texas: In Texas, the Technology Immersion Pilot (TIP) provides a school with the technology resources it needs to change teaching and learning (for teachers and students), on-going and sustainable professional development for teachers and leaders, the ability to utilize data in an on-going and sustainable manner, and the involvement of parents, leaders, and other stakeholders. This program focuses primarily on middle schools, and provides the environment and support to maximize the potential of technology to transform teaching and learning. A recent article succinctly highlights the results in two districts: *http://www.thejournal.com/articles/20931—1.* The program site can be found at: *http://www.txtip.info/*. Findings include:
- Overall, discipline referrals went down dramatically with the changes in instruction and engagement, which provided additional opportunities for teaching and learning.
- In one school, 6th grade standardized math scores increased by 5%, 7th grade by 42%, and 8th grade by 24%.
- In Brady ISD, 7th grade math scores increased by 13 points.
- In Floydada ISD, 6th grade standardized math scores increased by 29 points, and 10th grade standardized math scores increased by 36 points.
- Utah, Missouri, and Maine: In Utah, Missouri, and Maine, the eMINTS program provides schools and teachers with educational technology tools, curriculum, and over 200 hours of professional development to change how teachers teach and students learn. Utilizing 21st Century skills, relevant content, and collaboration are all key to the instructional strategies used in eMINTS classrooms. eMINTS changes how teachers teach and how students learn. Students in eMINTS classrooms no longer have to "power down," disconnect or disengage from the excitement and motivation the technology brings to their world. Teachers in eMINTS classrooms at all grade levels (3-12) report significant increases in student attendance and significant decreases in student behavior disruptions. Students in eMINTS classrooms are fully engaged in authentic projects that utilize technology and provide opportunities for students to hone the skills they will need to compete in the 21st Century, Missouri has evaluated this program for 8 years, and other states are conducting evaluations, as well. The following link provides a strong overview of the program: *http://www.emints.org/* and findings are found at *http://www.emints.org/evaluation/reports/*. Findings include:
- In Utah, classrooms in the same school (one with eMINTS and one without), the student achievement of students in the eMINTS classroom was repeatedly over 10% higher than the control classroom. In Title I buildings participating in the eMINTS-4-Utah initiative, a greater percentage of 4th—6th grade students enrolled in eMINTS classrooms scored at proficient levels on the UPASS CRT tests for language arts, mathematics, and science than did 4th-6th grade students in non-eMINTS classrooms.
- After 6 years of data in Grade 4 Mathematics, eMINTS students in subgroups (special education, low income, and Title I) have reduced the gap in test scores between their performance and their peers by up to ½ of the difference attributable to subgroup classification.
- In another district that had not met AYP goals, teachers began implementing the eMINTS program. After using the eMINTS approach with extensive professional development, the 3rd grade math scores increased by more than the 15% goal and made AYP in every subgroup.

In addition to the systemic reform approaches mentioned above, states and districts are experiencing success in key areas for improving math achievement for more students, including:

• Access to Rigor and Remediation (Alabama):Alabama's ACCESS (Alabama Connecting Classrooms, Educators, and Students Statewide) has redesigned the model for distance learning, by tailoring rigorous online courses and interactive videoconferencing services to the needs of individual students. The program is currently offering 10 AP courses—many of the enrollments are from rural schools that had never offered an AP course before. Dr. Major-McKenzie, superintendent of the rural Dallas County School System, states that, "ACCESS has helped the Dallas County School System maintain and expand course offerings when we were either unable to recruit or fund a highly qualified teacher. Without ACCESS, students at my high schools would not have been able to participate in courses such as Advanced Placement Calculus, Latin, or Shakespeare. Additionally, almost 5,000 students have received remediation and supplemental resources and more than 14,000 half-credits have been awarded. With high-quality courses that are engaging students through the utilization of 21st Century skills, Alabama is addressing its immediate need to decrease school dropout rates, increase high school graduation rates, and prepare its students to be competitive on a global scale."

• Student Engagement: Building Conceptual Understanding, Collaborating with Others, and Motivating Students (Oregon): In Oregon, students built collaboration skills, confidence, and critical thinking. Teachers shared that there is nothing more amazing than watching a young, shy child stride up to the front of the classroom, place their math work under the document camera and confidently explain to their classmates the way and the why of how they solved the problem. Technology offers this student the opportunity to share his/her work in this way, gives student opportunities to share their learning, speak publicly and to defend their thought processes. Oregon Department of Education has realized how interactive whiteboards and tablets in their classrooms enhance student learning. One of the teachers using these tools in her classroom is a middle school math teacher. She enthusiastically reports that the level of engagement amongst her students has risen dramatically and that she has the ability to move around her room for better classroom management.

• Building 21st Century Skills & International Awareness in Math (Illinois): A small school in Villa Park, Illinois participates in World Math Day. This amazing event allows the whole school, including teachers to participate in around the world math competition. This child-centered educational website selects 4 users out of 160 participating countries to compete in simple addition, subtraction, multiplication, and division facts in 60 seconds. During the game users can see the flag and map of the countries they are competing against, as well as the progress of the other users in the game. At the end of the 60 seconds, the user is given a progress summary with correct answers to missed problems. Upon breaking record scores, users achieve credit. The Villa Park school had a record of approximately 70,000 correct questions answered on March 7, 2008. A new world record was set, with over 182,450,000 math problems solved in one day.

• Student Engagement: Building Conceptual Understanding, Collaborating with Others, and Motivating Students (New Jersey): Wharton Borough Public School District in New Jersey developed a program focused on integrating technology into the math curriculum in grades 6-8. In the Bridge Project, students plan for the construction of a new bridge over the Hudson River to meet the needs of the expected increase in future traffic. Teachers report that students are highly engaged, spend more time on task, and are reluctant to leave/miss Math class for other activities. Overall, last year the percentage of students scoring in the GEPA Mathematics (state standardized test) proficient ranges increased to the highest percentage in the district's history (69.8%). The bridge project was one part of New Jersey's Math Achievement to Realize Individual eXcellence (MATRIX) grant program (2004-2007) designed to increase student achievement in mathematics in grades 6 through 8 by providing classroom teachers with ongoing professional development and in-class support that focuses on integrating technology into the curriculum and instruction. In Gloucester City Public Schools, a low-socioeconomic area "in need of improvement" interactive white boards were introduced into middle school math classrooms. Multimodal lessons addressing visual learners were posted to the district's servers making them available to all teachers. Math scores in this middle school have increased by 16 percentage points since the program was implemented.

• Blended Approaches to Address Varied Learning Styles (Texas): Brownsville in Cameron County, La Joya ISD, and Pharr San Juan Alamo ISD in Texas utilize enVisionMath which utilizes a blend of print, digital and active paths to engage and challenge students and support teachers as they address different learning styles and differentiate instruction.

Professional Development: Training That Changes Practice and Instruction

Professional development must change teacher practice and instruction to effectively increase math achievement. Joyce and Showers (2002, 1995) found that the isolated, workshop approach has less than a 5% chance of influencing instruction, but on-going and sustainable professional development involving modeling, mentoring, and/or coaching increases the likelihood for teachers to change instructional practices to almost 90%. States, districts, and schools can utilize technology to get beyond the traditional two hour workshop and provide meaningful professional development and resources to teachers. Teachers can engage in on-going and job embedded professional development through access to on-line courses, professional learning communities, and education portals with resources and lesson plans. This is particularly critical in rural and inner-city areas where these opportunities are often limited. Instructional technology coaches or mentors in schools provide opportunities for collaboration on planning and co-teaching to help teachers utilize new practices and resources. The systemic reform approaches identified above in the Texas TIP, Missouri eMINTS, and North Carolina IMPACT programs each utilize high quality professional development with these important qualities.

• Instructional Coaches or Mentors (North Carolina): IMPACT schools is largely a result of the role the school library media coordinator or technology learning facilitator plays in working with small groups and individual teachers to provide professional development and modeling as more and more technology is used to engage students in instructional units. Teachers work together to develop new lesson plans, consider how to facilitate learning, and utilize data to individualize instruction. As ideas are shared, new technology tools are incorporated to enhance the unit. Often the new tool is demonstrated or even taught during the meeting, or a special training date is determined for additional professional development. This type of planning and collaboration among teachers results in a transformation of learning, and the results are significant.

• Improving Content and Pedagogy (Louisiana): Louisiana is offering online professional development courses to help teachers engage students in Math. They are providing online courses so that they have the capacity to reach more teachers, in more districts and schools, and better prepare them for their roles in the ever-changing classroom setting. 12 modules were developed covering topics from Concept of a Variable to Measures of Central Tendency. Each module focuses on a specific algebraic content topic and includes elements of instructional strategies and lesson planning. Furthermore, modules include online readings and resources, interactive activities, online discussion prompts and optional enrichment activities.

• Online Courseware & Use of Data (Delaware): Delaware provides access to online courses through eLearning Delaware. Teachers have access to several clusters of courses, including the Secondary Math cluster focused on the skills and knowledge necessary to use virtual manipulatives with algebra lessons; applying meaningful data to apply in the math classroom; and developing strategies to encourage and promote the formation of algebraic thought processes in students. Teachers take three online courses developed by EDC (Education Resource Center): (1) Getting Ready for Algebra with Virtual Manipulatives; (2) Using Real Data in the Math Classroom; and (3) Using Patterns to Develop Algebraic Thinking. Each course takes place entirely online over a six-week period, and the culminating activity is the piloting of three lessons developed throughout the three courses. Teachers connect with other teachers in the on-line environment to ensure on-going and sustainable professional development.

• Professional Learning Communities and Education Portals: As our education system strives to ensure that our students are competitive in a 21st Century global economy, it is critical that educators have access to high quality resources, data, and tools to guide teaching and learning. An Education Portal is a one-stop resource for educators to support teaching, learning, and leading. Portals include access to resources and an entry point to other information or services, including subscriptions or data systems, content standards, lesson plans, courses of study, Web resources, listservs, and other educational resources. This includes technology-based curriculum resources and tools that promote 21st Century teaching and learning. A portal allows educators to quickly search for lesson plans or other resources by content standard, grade level, and/or topic. Ideally, a portal also provides an on-line community for educators to collaborate and discuss teaching and learning and experiences as an educator. State-wide portals provide equity of access to teachers regardless of district, high quality resources that address teaching and learning needs to ensure students are prepared for the 21st Century global economy, on-line communities of learning to support the improvement of teaching and learning, and access to formative assessments and other resources to address various learning styles, needs, and achievement levels. Alabama, Arizona, Massachusetts, and other

states have implemented portals as an essential part of professional development and resources for teaching math. The Ohio example from Garfield Heights includes achievement data:

• Ohio: eTech Ohio and the Ohio Department of Education (ODE) helped schools develop and implement lessons aligned to the academic content standards for math and English/language arts. This set of web-based curriculum management and instructional design tools allow for online content/course development and management, or an "off-the-shelf" course/learning management system. Maple Leaf Intermediate School in Garfield Heights, Ohio serves approximately 600 students. Maple Leaf is considered a Title I school and 50% of the students are eligible for free or reduced lunch. Maple Leaf has a very diverse ethnic population: 33% of the students are African American, 63% are Caucasian, 2% are Asian, 2% are Hispanic, and less than 1% are Filipino. Student achievement in mathematics dramatically increased as the school increased the use of technology in daily classroom instruction. Of two classes taught by the same teacher, the class that utilized the CompassLearning online tool has a 14% higher passage rate on the Ohio Math Proficiency Test than that of the class that did not use this technology tool.

Formative Assessment: Using Real Time, On-going Data to Individualize Instruction

Timely information about individual students is a critical component in changing the way that teachers teach and students learn math. Statewide longitudinal data systems are very important for accountability and reviewing overall curriculum and instruction. Additionally, teachers need access to data to assess the progress of their students on a regular basis in order to individualize instruction, allowing for the remediation or enrichment as needed, for each and every student. Many districts and states are utilizing programs and systems that provide teachers with formal and informal assessments to track student progress weekly or even daily. This keeps students on-track with achievement, but also provides opportunities for students to participate in engaging activities based upon abilities and needs. The examples below provide two approaches to tying formative assessment to the curriculum to individualize instruction:

• Michigan: Several districts in Michigan utilize Carnegie Learning's Cognitive Tutor for Algebra I, a software program that assesses students' individual needs, creates an easy-to-follow regimen, allows students to work at their own pace, provides instant feedback, and can be used on any computer in any location. Wayne Regional Education Service Area is just completing its first year of a partnership with Carnegie Learning originally designed to address mathematics deficiencies in High Priority schools, and was ultimately expanded to allow all districts in the county to participate. In the first year they've provided math curriculum to 10,000+ students in 16 districts, and have provided professional development to upwards of 500 teachers on how to positively impact mathematics student achievement using the Cognitive Tutor. Taylor Public Schools has effectively implemented the Carnegie pedagogy, and as a result, student achievement in mathematics has dramatically increased. Further, and perhaps more telling, is the dramatic decrease in failure rates the district saw compared to previous years. In years past, Taylor has selected those higher achieving students out of 8th grade to take Algebra 1 in 9th grade. Historically the failure rate for those "high achieving" students came in around 45%. This school year, ALL 9th graders were required to take Algebra 1, including Special Education students, and the failure rate has decreased to 15%-20%.

• Virginia: Virginia's Algebra Readiness Initiative (ARI) assists in preparing students for success in algebra through a computer-adaptive test (CAT). School divisions are eligible for incentive payments to provide mathematics intervention services to students in grades 6-9 who are at-risk of failing the Algebra I end-of-course test as demonstrated by their individual performance on diagnostic tests that have been approved by the Department of Education (DOE). The diagnostic test results allow teachers to individualize the content for intervention. A pilot study conducted during the 2005-2006 school year to explore the efficacy of this approach in grade 5 showed that students improved over 80 scale score points between the pre and post Algebra Diagnostic Test during the school year. Teachers reported that the ARI helped determine the learning styles of the students and ultimately modified the teaching accordingly. Some students like formulas, while others relate to examples, scenarios, and hands-on activities. The professional development associated with the ARI requires a lot of one-on-one follow-up with teachers. It was also reported that providing students with a variety of software choices helped students that needed different ways of learning.

Conclusion

The good news is that we have identified strategies and programs that make a difference for math achievement. These strategies and programs also happen to make a difference across the core subject areas, as well as 21st Century skills and other education indicators. Specifically:

- The use of technology can support the teaching and learning of mathematics by bringing a multitude of learning experiences to captivate student interest and build mathematics understanding, proficiency, application and confidence.
- Mathematical understanding is increased when students and teachers use and apply technology to investigate mathematical concepts; including visualization, modeling, representation, simulation and communication.
- All educators and students should have access to the resources and technology to support teaching and learning of mathematics at school and home.
- Students learn mathematics in different ways, and we need to provide technology, resources, varied instructional strategies and skills that allow them to excel, deepen their understanding and maximize their potential.
- Students build mathematical knowledge and understanding of mathematical concepts through problem solving.
- Educational technology strengthens the connection of mathematical topics in different contexts.
- Using formative assessment in mathematics provides on-going data for teachers to individualize instruction based on needs. This leads to increased achievement in math.

The Committee has demonstrated its focus on the critical role that technology plays in our education system by the inclusion of the EETT Program in NCLB and the ATTAIN Act in the draft reauthorization bill of ESEA. The ATTAIN Act focuses on the need for systemic approaches to technology implementation and recognizes the critical role technology plays in the use of data systems to individualize instruction, on-line assessments, virtual AP Courses, and on-going and sustainable professional development. Many states currently use educational technology to reach these goals which have shown to improve student achievement, certify highly qualified teachers and help close the achievement gap—particularly in regard to math.

The ATTAIN Act provides an important role in helping more states, districts, and schools implement systemic reform models and on-going and sustainable professional development that have been proven to improve student achievement in core subject areas and ensure that students are competitive in the 21st Century global workforce.

Federal leadership must be bold and act as a catalyst to change how we teach, learn, and apply math for America's and our students' competitiveness and innovation. Maximizing the impact of technology's role in our education system is possible, but it will take a concerted effort by you, the states, districts, educators, and all stakeholders. We can achieve a 21st Century Education system for all students. We ask that you specifically recognize and support the role of technology in all education legislation, including throughout the Reauthorization of ESEA and the America COMPETES Act. We cannot afford to miss the opportunity that technology provides to engage students, to improve instruction and teacher quality, and to ultimately raise student achievement in math so that our students are prepared for the 21st Century.

Chairman MILLER. Thank you.

John?

STATEMENT OF JOHN J. CASTELLANI, PRESIDENT, BUSINESS ROUNDTABLE

Mr. CASTELLANI. Thank you, Mr. Chairman, Ranking Member McKeon, members of the committee. Particularly Mr. Miller and Mr. McKeon, thank you for participating with us yesterday on another very important part of the education issue, the role of community colleges.

Across every sector, our CEOs are united in their concern about the continuing reality that far too many students are not graduating from high school with the knowledge and skills they need to succeed in either higher education or at the workplace.

The No Child Left Behind Act is beginning to make a difference, but troubling achievement gaps remain between groups of students in the United States, and between U.S. students and their international counterparts, particularly in math and science education. We believe that expanding the talent pool of Americans with a firm grounding in math and science is a critical element of the innovation agenda that the United States must pursue to remain competitive in the 21st century.

That is why the Business Roundtable through its Tapping America's Potential coalition of 16 national business organizations established the goal of increasing the number of Americans graduating with an undergraduate degree in science, technology, engineering or math to 400,000 per year by 2015. The current figure is 225,000.

Business Roundtable CEOs believe that graduating more students in these key majors is a necessary step toward ensuring continued U.S. technological and economic leadership. Just as important, grounding in these subjects is increasingly necessary for individual success in the modern economy.

The Bureau of Labor Statistics projects that science and engineering employment in the United States will increase 70 percent faster than the rate for all occupations during the next decade. America will create more and more high-wage jobs for technical professionals. The question we face is whether or not our children will be qualified to fill them.

It is clear that the United States cannot achieve the TAP goal of 400,000 math, science, and engineering graduates annually without first raising U.S. student achievement in mathematics. Math is the gateway that frequently is the reason why students are unprepared to pursue careers in these fields. By the time a student is in the eighth grade, if he or she is not on a path to succeed in algebra, high-wage job opportunities diminish.

There is widespread understanding about the importance of learning to read as the foundation for further learning. There is an equally compelling case for the importance of a strong foundation in mathematics. Many companies have programs that introduce elementary and middle school students to exciting careers in science and engineering and give them hands-on experience with interesting science experiments.

However, the companies recognize that it is not enough to get students excited about the future in these fields. They also need a foundation of math skills that can turn that excitement into a real possibility. What I would like to do is just talk about two of many examples.

Texas Instruments has partnered with the CBS television show NUMB3RS, which features a mathematician working with his FBI agent brother to solve crime. TI has also developed a math scholars program at the University of North Texas-Dallas Campus that ensures full scholarships with book stipend to students pursuing their bachelor of arts degrees in mathematics with a secondary certification. The students teach in Dallas for a minimum of 2 years in return for this scholarship opportunity.

Another example is ExxonMobil, which has partnered with professional golfer Phil Mickelson and his wife Amy to launch the Mickelson ExxonMobil Teachers Academy, and provides third-

through fifth-grade teachers with the knowledge and skills necessary to motivate students to pursue careers in science and math.

In addition, ExxonMobil Corporation has committed $125 million to the National Math and Science Initiative, which is working with states and universities to scale-up two proven programs: first, the training and incentive programs to increase the number of students taking and passing advanced placement math and science courses; and second, Uteach, a program that encourages math and science majors to enter the teaching profession by offering an integrated degree plan, financial assistance, and an opportunity for early teaching experience for undergraduates.

These and other corporate initiatives are making an important contribution, but policies also need to change. As the National Mathematics Advisory Panel recommendations point out, a critical bottleneck in U.S. math education is the inadequate supply of well-qualified and highly prepared math teachers.

That is why our member chief executive officers were so enthusiastic about the math and science education legislation enacted last year as part of the America COMPETES Act was included, but time and again, we learn that well-intentioned math education initiatives fail because of inadequate attention to high-quality teacher preparation and professional development.

Mr. Chairman, this committee focuses on education and workforce issues, and those issues will determine whether our students and workers can compete and succeed in our rapidly changing world economy. The education and workforce policies and programs of the last century are not designed to meet the challenges that we are facing today.

We stand ready to work with the committee on new approaches for the 21st century. I thank you for your leadership and for the opportunity to testify today. I would be happy to answer questions. Thank you.

[The statement of Mr. Castellani follows:]

Prepared Statement of John Castellani, President, Business Roundtable

Mr. Chairman, Ranking Member McKeon, Members of the Committee. Good morning. I am John Castellani, President of Business Roundtable.

Thank you for inviting me to testify before you today on math education and the recent report issued by the National Mathematics Advisory Panel.

I want to thank the members of the Advisory Panel for their important work on behalf of education in the United States.

Business Roundtable is an association of chief executive officers of leading corporations with a combined workforce of more than 10 million employees and $4.5 trillion in annual revenues. Across every sector our CEOs are united in their concern about the continuing reality that far too many students are not graduating from high school with the knowledge and skills they need to succeed in either higher education or work. The No Child Left Behind Act is beginning to make a difference, but troubling achievement gaps remain between groups of students in the United States, and between U.S. students and their international peers, particularly in math and science education.

CEOs believe that expanding the talent pool of Americans with a firm grounding in math and science is a critical element of the innovation agenda that the United States must pursue in order to remain competitive in the 21st century. That is why Business Roundtable through its Tapping America's Potential coalition of 16 national business organizations established the goal of increasing the number of Americans graduating with an undergraduate degree in science, technology, engineering or math to 400,000 per year by 2015. The current figure is about 225,000.

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nomic leadership. Just as important, grounding in these subjects is increasingly necessary for individual success in the modern economy. The Bureau of Labor Statistics projects that science and engineering employment in the United States will increase 70 percent faster than the rate for all occupations during the next decade. America will create more and more high-wage jobs for technical professionals. The question is whether our children will be qualified to fill them.

It is clear that the United States cannot achieve the TAP goal of 400,000 math, science and engineering graduates annually without first raising U.S. student achievement in mathematics. Math is the gateway that frequently is the reason why students are unprepared to pursue careers in these fields. By the time a student is in 8th grade, if he or she is not on a path to succeed in Algebra, high-wage job opportunities diminish.

There is widespread understanding about the importance of learning to read as the foundation for further learning. There is an equally compelling case for the importance of a strong foundation in mathematics. Many companies have programs that introduce elementary and middle school students to exciting careers in science and engineering and give them hands-on experience with interesting science experiments. However, the companies recognize that it is not enough to get students excited about futures in these fields. They also need to get the foundation of math skills that can turn that excitement into a real possibility.

For example, Texas Instruments has partnered with the CBS television show NUMB3RS, which features a mathematician working with his FBI agent brother to solve crime; TI also has developed a Math Scholars program at the University of North Texas Dallas Campus that offers full scholarships with book stipend, to students pursuing their Bachelor of Arts degree in Mathematics with Secondary Certification. The students teach in Dallas for a minimum of two years in return for this scholarship opportunity.

ExxonMobil has partnered with professional golfer Phil Mickelson and his wife Amy to launch the Mickelson ExxonMobil Teachers Academy which provides third-through fifth-grade teachers with the knowledge and skills necessary to motivate students to pursue careers in science and math. In addition, Exxon Mobil Corporation committed $125 million to the National Math and Science Initiative, which is working with states and universities to scale-up two proven programs:

- training and incentive programs to increase the number of students taking and passing Advanced Placement math and science courses, and
- Uteach, a program that encourages math and science majors to enter the teaching profession by offering an integrated degree plan, financial assistance, and early teaching experiences for undergraduates.

These and other corporate initiatives are making an important contribution. But policies also need to change. As the National Mathematics Advisory panel recommendations point out, a critical bottleneck in U.S. math education is an inadequate supply of well-qualified and highly prepared math teachers. That is why our member CEOs were so enthusiastic about the math and science education legislation enacted as part of the America COMPETES Act last year. Time and again, we learn that well-intentioned math education initiatives fail because of inadequate attention to high-quality teacher preparation and professional development.

Mr. Chairman, this Committee focuses on the education and workforce issues that will determine whether our students and workers can compete and succeed in our changing world economy. The education and workforce policies and programs of the last century were not designed to meet the challenges we are facing today. Business Roundtable stands ready to work with you on new approaches for the 21st century. I thank you for your leadership and for the opportunity to testify today. I would be pleased to answer any questions you may have.

Chairman MILLER. Thank you very much, and thank you to all of the members of the panel.

Dr. Fennell, somewhere I saw a graph, or competing graphs, or PowerPoint slides or something, and one was supposedly a representation of how we present math in grades one through twelve. The other was how other countries present math. One was very scattered, very psychedelic, unconnected.

Mr. FENNELL. I know the graph you are referring to.

Chairman MILLER. Oh, you know the graph. Okay. Maybe you can give it a better description, and if you could explain it and

what the implications that the Math Panel thinks of those terms. I am sorry we don't have it. I don't think we have the graph here for the members.

Mr. FENNELL. No, you wouldn't want to have that graph. It would probably confuse most people in the audience. But it comes from the work of Bill Schmidt. It comes from the work of Trends in Mathematics and Science. What he did was he looked at high-achieving countries and their mathematics curriculum, and then he put a scattershot of a number of the states in this country.

The reason I say you probably don't want to show the graph, it would probably burn the eyes of the viewers because in this country, we introduce and frankly do a scattershot of a myriad of mathematics objectives and outcomes and expectations. In those other high-achieving countries, the number of expectations are far fewer so that in fact the teachers can reach the level of depth that children need as they move on to other mathematics.

I can and should say it is stronger than that, the work of both NCTM and in particular the National Math Panel's critical foundations and benchmarks really looked at that work very, very carefully, and hence critical foundations—absolute must-haves that every state ought to attend to.

Chairman MILLER. So when you were talking in your testimony about being focused here——

Mr. FENNELL. You know, I can't expect the fourth-grade teacher who frankly has a limited background in mathematics to think that among even 60-some objectives, which are the most important. So it is our job, through this report and the initiatives of groups like NCTM, to make sure that teachers know that. I know that there are people in this room from Florida and other states where they have actually done this, where they have taken 80-some objectives in a given year and condensed that down to 30-some. So some states are getting this message.

Chairman MILLER. Okay. I want to hold that thought for a second because that is a recommendation about the direction that the Math Panel believes school districts should go in terms of developing——

Mr. FENNELL. Your remarks earlier about streamlining are right at the heart of that.

Chairman MILLER. So, Ms. Slover, you work with governors and states, and you mentioned in your testimony that a number of them are making these kinds of improvements. But I have a question for you. If that is a recommendation, some states are doing it, and there is an agreement that we have to have a more coherent way of presenting and building early strengths so that you can build on those, what is the role of the federal government there?

Ms. SLOVER. One role for the federal government is to empower states to do that, and to encourage them in providing incentives for them to do that. As Dr. Fennell alluded to, states are moving in the right direction. They are taking a look at their standards and making tough choices about what everybody would like to have students know versus what is most important for students to know, because it prepares them for what comes next in life, whether they are going to college or whether they are going into careers.

To have that conversation, you need the right people in the room. You need K-12 educators, obviously. You also need the business folk and you need the college professors to help inform the conversation about what is most important. States are moving in the right direction and cutting down and focusing their curricula.

Chairman MILLER. In your testimony, in your presentation, you have 33 states that you indicate Achieve has worked with, and you think they are moving in the right direction. They are not all at the same place, but they are moving in the right direction. You mentioned that you have 13 states that now at some point, or this spring, are taking a common exam in math.

So then, again, the federal government should do what? Allow flexibility in funding to support that?

Ms. SLOVER. Absolutely. We have 14——

Chairman MILLER. We have killed more initiatives than we have created, so I just want you to think about it while you are roaming around out there. [Laughter.]

Ms. SLOVER. We would love the federal government to provide space and flexibility for states. Many more states are looking to end-of-course exams to directly measure the content in the courses that students take, which enables a little bit more fidelity to the curriculum than some of the more comprehensive exams that states are giving. So we would encourage the federal government to encourage states to move in that direction.

Chairman MILLER. And Achieve is comfortable with the rigor of the exam in the 13 states in terms of your goals and your mission?

Ms. SLOVER. Yes. The 14 states have worked together over the last 2 years to develop the content expectations, the items, and now to pilot and to offer the test. We have taken a look at the test. This particular test is very rigorous. Not all exit exams are necessarily so, but they do offer the opportunity to be more closely aligned and more tightly connected to the curriculum, which provides teachers and students with a lot of benefit.

Chairman MILLER. What is the reason you don't have 20 states taking the exam?

Ms. SLOVER. I can't answer that. More states are certainly invited to join this group.

Chairman MILLER. They don't have the capacity? I mean, they wouldn't be comfortable submitting their students to that? Do you know?

Ms. SLOVER. We started out with nine states, and we have grown significantly over the last year, so I think there is momentum. Additional states are joining as we speak. But this is a rigorous exam. It is at the algebra II level. Most states are currently testing their students at the algebra I or below level. So it is a significant shift for states. It will take some time to phase in as they grow their expectations for their students.

Chairman MILLER. It is very encouraging. One of the things that Congressman McKeon and I tried to do in the discussion draft on No Child Left Behind was look at what the governors and states are doing and try to encourage those who are stepping out in that vein. I don't know if the Math Panel looked specifically at that, just to finish off this discussion, but in terms of whether there is enough infrastructure being built so that the federal government

would be more comfortable in allowing the flexibility of funding to be directed if you are confident that you are gaining rigor and improvements.

Mr. FENNELL. I would think that the benchmarks that come out of the critical foundations that lead to algebra are certainly guideposts for states as they think about the must-haves as they move into high school. And then, as you know, with No Child Left Behind, there has to be a high school assessment. It is the courageous state that might at some point say, well, our high school assessment might even be the ADP examination in algebra II.

So the notion that 14 states have already—and I think the word is "already"—thrown into this I think is significant.

Chairman MILLER. Thank you. We will have a second round of questions.

Mr. McKeon?

Mr. MCKEON. Thank you, Chairman Miller.

Dr. Fennell, you talked about countries that are high achievers. What would be some of those countries?

Mr. FENNELL. Well, most frequently people refer to Singapore. It is easy to refer to many of the Asian culture countries. It is also probably worthwhile to look at Flemish Belgium. It is also worthwhile to look at other European countries. But coming to us as we did our work, we were tying pretty carefully to what is going on in Korea, what is going on in Singapore, Japan, as specifics.

Mr. MCKEON. The European countries that I am familiar with all have a centralized——

Mr. FENNELL. Yes, as do the Asian culture countries that I just referenced.

Mr. MCKEON. Okay. So if we were one of those countries, we could listen to this panel. All are very distinguished and presented very good cases of things that should be done. And then we would just inculcate that and send out the message and it would all of a sudden happen in all 50 states.

We have a different system. So we have to grapple with the states.

Ms. Slover, you were asked what could the federal government do. I think your response was "empower." The states are already empowered. They have the responsibility. We see the problem as a national problem that needs to be solved at 50 different areas, and within those areas, at the local school board level.

At times, it causes I think a lot of frustration. I served on a local school board, and I saw the needs there. I remember during that period of time we lost two of our best math teachers to industry because, as much as they wanted to be math teachers, finally the offers got too good for them to stay teaching.

One of the things that you did talk about, though, was the specialist teachers, and if we could encourage that at all elementary schools. How would you envision that? The school would hire a specialist?

Mr. FENNELL. The panel's work looked at it—and by the way, Bill Haver is a noted authority on this. The work in Virginia is stellar, and it is coming, and there is going to be research that will drive a particular direction to the model of elementary math teacher specialists. But the model that we found right now that does

work is if I anoint somebody and say, all right, you are in charge of all the fourth-grade mathematics, and somebody else is doing all the fifth-grade mathematics, and your teaching load, if you will, is primarily mathematics, we do see achievement gains in that model right this minute. So that is something that could happen.

Mr. MCKEON. That is what Dr. Haver was talking about in the areas that they are working in.

Mr. FENNELL. Yes. And his model is a little different because they are looking at elementary specialists at the building level and so forth. But I also think that one of the challenges we have is generalist teachers at the elementary school level at a time when we are looking for developing specific background in mathematics and science. So why not begin pre-service teacher preparation with opportunities for people to move in and teach a lot more mathematics than typically?

Mr. MCKEON. What incentives would we give to those teachers to get the adequate education, and then the motivation to do that, and to stay in the teaching field?

Mr. FENNELL. I think you hit on it, in your local example and in your last statement, one of the biggest challenges. Teachers of particularly high school mathematics are very, very hard to find. The majority of people teaching middle school mathematics in this country at this moment have neither a degree nor a minor in mathematics, at a time when more and more students are taking algebra at the middle school level. It is a tremendous problem for us.

Of course, we know that foundationally this has to happen at the elementary school level. So not only do we need teachers, but probably more importantly, we need to find a way to keep them, because in fact if you have that background that I just alluded to, you have options. That is why you lost those two teachers you referred to in your own example.

Mr. MCKEON. Some of us went to China a couple of years ago. We visited with government leaders, industry leaders, education leaders. We visited a lot of schools and talked to students. The thing I noticed was a sharp contrast between China and our country: all of the university presidents were engineers over there. That is their background. Ours seem to be fundraisers. They come from a broad liberal arts or an education degree, and then move through the system that way.

Well, I guess we have more problems, more answers, than we are able to implement.

Mr. FENNELL. Well, that is part of that value thing, don't you think?

Mr. MCKEON. Pardon?

Mr. FENNELL. I said that is part of that value thing, don't you think?

Mr. MCKEON. Oh, yes, yes.

Mr. FENNELL. This culture of ours needs to get over this math gene business, this business that only certain people ought to do this subject, or science or engineering. We heard the numbers earlier. It is time to step up.

Mr. MCKEON. Yes. Thank you.

Chairman MILLER. Thank you.

Mr. Kildee?

Mr. KILDEE. Thank you, Mr. Chairman.

Dr. Staggers, I was a Latin teacher. Only because of pride and memory, I got A's in math. I went as far on as trig, but got A's in math. I really was discovering little or nothing. I never had like "eureka" moments of joy when I worked the problems. But because of pride and memory, I knew how to lay out the problem.

You indicate that real applications for math and science, while preparing the student for the workforce, are post-secondary education. How do you put that theoretical math together with some practical application where one can have that "eureka" moment, and realize that this math plays a very, very important part in their life and the lives of our society?

Ms. STAGGERS. In mathematics in high school and middle school, for example, you study inequalities—less than, greater than, and so forth, less than, greater than, and equal to. Those are basically tolerance intervals. So in manufacturing, you look at that range of values as plus or minus, say, five-thousandths of an inch when you are measuring a part in manufacturing.

Some of the algebra and trig that is used where you are just simply looking at right triangles, in engineering when you are designing bridges, truss structures for roofs or walkways—any kind of inclined plane—you need to use those angles and that trig to figure out distances.

So rather than just take a problem out of a math book and say, you are given this, find that, actually give them a realistic problem where you want to put so much force on this structure, and what types of beams do I need to have under that structure. So with that application, the students realize the importance of their calculations to a certain degree. It is not "did I get close." It is very important that you got it right. [Laughter.]

Mr. KILDEE. I never had those "eureka" moments, where I got this right and it is going to make a difference.

Ms. STAGGERS. Well, if you are putting two parts together and you are designing a part to go in your car, if the part is not designed properly, even the slightest fraction of an inch, it is not going to fit.

Mr. KILDEE. Coming from a General Motors town, I realize the importance of that. [Laughter.]

Dr. Fennell, you mentioned that teachers in junior high who really for the most part could have a better background in math. Do they illustrate to the student the application or how this really does play a role in their lives and the lives of our society?

Mr. FENNELL. Well, I would certainly like to hope so. It seems to me that we need—I mean, one of the things we sort of get into when we have discussions like this is this sort of cultural comparison. We have to acknowledge that frankly our kids are different, and that we do need to get them connected to the mathematics they are learning.

The notion of tolerance that we just heard, whether you are going to be able to get over the bridge, whether you are going to be able to start your car, if that doesn't get a kid sort of connecting with the mathematics that they are learning relative to inequality, I don't know what would.

So that notion that equipping teachers to be able to do that, rather than just going through the motions of, if you will, I heard the comment earlier about your grandfather's mathematics or perhaps the mathematics that you and I learned so many years ago.

Mr. KILDEE. Well, I got A's in math, but I would have hesitated to drive my GM car over that bridge. I really was not able to connect.

Mr. FENNELL. I thought that was a great response to your question in terms of how to really connect it to a life-like situation.

Mr. KILDEE. Thank you very much.

Thank you, Mr. Chairman.

Chairman MILLER. Thank you.

Mr. Keller?

Mr. KELLER. Thank you, Mr. Chairman.

I am the father of four small children. I can tell you anecdotally I thought I was dealing with a math problem with my 12-year-old son. I asked him if you had five apples and I asked you for one, how many apples would you have? He said five. I said, wouldn't you have four? And he said I am not giving you any of my apples. So I didn't have a math problem. I had a little Republican on my hands coming up the ranks here. [Laughter.]

Let me ask you, Ms. Slover. You work with the different states. Last time I looked at the NAEP scores a few months ago, I believe it was Massachusetts that was number one in the country for fourth-grade math and eighth-grade math. Is that right?

Ms. SLOVER. Yes, that is correct.

Mr. KELLER. Okay. And Dr. Fennell, you are saying that?

Mr. FENNELL. Yes, right.

Mr. KELLER. Let me ask both of you, since you are familiar there, is Massachusetts doing something different that maybe the other states can learn from? Or is it just socioeconomic factors? What are they doing that makes them number one, and that the rest of us can learn from?

Dr. Fennell, I will let you go first.

Mr. FENNELL. I am happy to take that one on. I think that there are two things that come immediately to mind, and you hit one of them. One is whenever you begin to do this sort of state-by-state comparisons, whether it is a national assessment or even your own state test, I do think you have to take into account the background of the students and where the students were and so forth. So I think that is part of, for instance, Massachusetts compared to Florida.

It is also part of the fact that the Florida standards were one of those states, up until the last year, that frankly had 89 objectives for classroom teachers at the fourth-grade level and so forth. Whenever you have that many perceived expectations, you can't dig deep. You don't really have the opportunity to drive down, because you are trying to scattershot and make sure that you hit all those—in the case of Florida, the FCATs—which then those students are samples for the NAEP.

The Massachusetts standards are trimmer, if you will. They are more closely tied to the National Assessment of Educational Progress. So what the students are seeing both in their expecta-

tions and their state test and the NAEP are just more compatible measures.

Mr. KELLER. Okay, more mainstreamed benchmarks that they are having to hit, and also a little different socioeconomic background?

Mr. FENNELL. Right. Yes, and again, I alluded to it earlier and I knew that you were from Florida. Florida has very recently taken those 89 objectives and gone all the way back down to 30, so they are clearly getting the notion of, if you will, less is more, and let's make sure that our students really know the important mathematics well, along with other mathematics, prior to this thing we call algebra.

Mr. KELLER. Ms. Slover, do you have any comment?

Ms. SLOVER. I completely agree with Dr. Fennell. Massachusetts has exemplary standards. We actually use them as an example of high-quality standards in our own work, and we share those with other states and hold them up as an example of how to do standards right.

Interestingly enough, Massachusetts does not have state graduation requirements. They allow the locals to make those decisions, so they are not using that graduation requirement lever, but they are providing incentives and encouraging their teachers to really look at those standards and do a lot of professional development around those standards.

Mr. KELLER. All right. Next, I am going to talk about teacher quality for a minute. I am going to give Dr. Staggers a chance to answer this, as well as Dr. Fennell.

Before I do, let me just say this. We are all sensitive on a bipartisan basis that we have a massive shortage of good math teachers. So we have passed legislation already that provides loan forgiveness—$17,500 if you agree to be a math teacher in a Title I school.

Three of us were just in the Oval Office a few days ago with President Bush and Senator Kennedy, when President Bush signed into legislation expanding SMART grants to provide $4,000 additional for Pell-eligible students who are going full-or part-time to become math majors. That will help 100,000 students and will provide them with $8,800 a year in Pell money that they never have to pay back, to increase the number of folks going into these fields. So we are sensitive to that.

Teacher quality. Raytheon just did a landmark study where they applied modeling and simulation principles to the education system to see how can we predict who is going to be successful in math and science. Do you remember that study, Dr. Fennell?

Mr. FENNELL. Yes.

Mr. KELLER. The number one correlation with whether or not you are going to pursue math at the college level, more than student-teacher ratio, more than poverty of your family, was whether you had a high-quality teacher. The number one thing that discouraged people from pursuing it is they had a bad teacher experience.

Are you familiar with that study, Dr. Fennell?

Mr. FENNELL. Yes.

Mr. KELLER. The biggest challenge that the researchers had was they can tell after someone has been teaching a couple of years whether they are a good teacher or not. It is pretty hard to tell

when you are doing your interview whether someone is going to be a good teacher or not. So let me just let Dr. Staggers and Dr. Fennell answer.

How do folks know on the front end, since you are involved in hiring math teachers, whether someone is going to be good? And then once they are there, how do you know that they are going to be good, to maintain the good folks and weed out the bad?

I will let Dr. Staggers start with that.

Ms. STAGGERS. I don't know if there is a way to tell off the bat if a teacher is going to be good. It is sort of like preachers, I want to say. They don't always start out good, but they get better as time goes on.

Mr. KELLER. Right. [Laughter.]

Ms. STAGGERS. And so up front, we may not know that, but seasoned teachers are good. If you find out that they are not good, there needs to be a way to rectify that very quickly, rather than just keep them on because the paperwork becomes too difficult.

Mr. KELLER. Dr. Fennell, I am out of time, but maybe the chairman will let you answer before we go to the next witness.

Mr. FENNELL. Yes, let me just say that what you refer to with regard to successful students and the impact of a teacher kind of picks up on the research of Sanders and Rivers in Tennessee, and also more recently the Dallas Independent School District, where essentially if a child has three ineffective teachers in a row, that child never recovers. So this is a tremendous challenge for us.

One of the frustrations in our work with the National Math Panel was it was clearly easy for us to see that teachers do make a difference, but what we couldn't get underneath of and say, well, is it certification? Well, is it an NCATE accredited teacher education program? Well, is it particular aspects of professional development?

It is one of those things where we don't know and we had better find out. As I said in my remarks, if colleges of education don't hear that and hear it loudly, I don't know what more needs to happen. I am a teacher-educator for 30-plus years, and I like to think that maybe the teacher-preacher model was part of what I did and continue to do, but we have to be far more strident in what we are doing preparing and nurturing and, again, retaining effective teachers.

Mr. KELLER. Thank you.

Chairman MILLER. Thank you.

Ms. Woolsey?

Ms. WOOLSEY. Thank you to this panel. This has been an excellent morning, but it makes me very frustrated, so you are going to hear all of this.

First of all, we know that you can't learn unless you can read, so reading is very, very important to our kids. You have proven without a doubt something that we also know, that the more math you learn, the more you earn, as Ms. Slover told us. But we also know that we have to educate the whole child. We have to have music. They need to know geography and history and the humanities.

So there are some things that we just know. That doesn't mean that we are wise enough to act on that. We know that a child who

eats breakfast learns better. They test better. Their discipline is better. Their attendance is better. We know that, but we don't feed all kids breakfast. I mean, it would cost too much money, obviously.

So what I am asking you, given what you want us to be doing, which I respect very, very much, even if we had good math teachers available, even if we valued teaching education in the first place, and math particularly, and we had the incentives and we had all these math teachers, where is the time to do all of this? What do we need to do differently? Where do we make room? Do we need to make our school year or school day longer?

I will start at the bottom and move up on that. Let's talk about where is the give in this formula.

Mr. CASTELLANI. One of the unfortunate parts of this, and I am not a trained educator, I should say, however, that I am the son of two teachers, one of whom is a math teacher and the other English. But the unfortunate reality is that there are no priorities among essentials. All that you talked about are essential, but one of the critical needs that we recognize right now, particularly as our economy is evolving, is math and science. Math particularly is a gateway.

It will allow us as a nation better economic growth, better competitive standing, and hopefully more resources for all of the spectrum of education that you mentioned. So I think all of the experiments that you have mentioned, and we have looked at a longer school day, a longer school year. From our perspective, it is very simple. These are the talents we need if we are going to own the higher end of the value-added chain in the future, and we have to find the way to do it.

Ms. WOOLSEY. Dr. Wolf?

Ms. WOLF. Thank you.

One thing that I have noticed is that as we worked to implement NCLB and accountability, it often seems like it is done in a way that contradicts what we know that works and makes sense. I don't think that is the intent of the law in any way, shape or form, but when you look at how in some schools and some districts they have reacted to those requirements, it doesn't involve 21st century skills. It doesn't involve interdisciplinary learning. It doesn't involve the depth that we are all talking about today that makes a real difference.

Now, when you say about the time, I have a deep interest in that topic. I will tell you that I think the response is that it is a systemic reform piece. We have looked at many programs, including the one I referenced in Texas, but North Carolina implemented one as well. They provided an instructional technology coach to those schools to work with teachers in groups. It started to save time, because there was co-planning and co-working. Using technology is one way.

I don't think technology is a silver bullet in any way, shape or form. But what we do know is it can help other things work really, really well. When we looked at those, what I find fascinating is teacher retention in schools in North Carolina, where achievement was 33 percent more likely to be on grade-level when technology

was used and these coaches were in place, teacher retention was 65 percent higher.

You would immediately think that is the young teachers, but it wasn't the case. It was also the master teachers because they were able to be creative and use the teacher skills they had to do all the things we have mentioned. So I think there is a real opportunity there to focus on those pieces.

Ms. WOOLSEY. Dr. Staggers?

Ms. STAGGERS. I think a weakness is that maybe teachers who teach music, art, history and these fields that you are speaking of don't realize that there is math in every one of these fields. So we don't really need to make the day longer. We need to incorporate the math that is found within them. Take the field of art, that is geometry. You could use a computer to do art with.

We do it with the Project Lead The Way introduction to engineering design course. In music, the timing—that is mathematics. In history, reading graphs, charts, timelines—all that is math. Every discipline that is taught in our schools has a math component. The teacher who teaches that discipline needs to be prepared to pull the math out of it and introduce it.

Ms. WOOLSEY. Thank you.

And Mr. Chairman, I will ask the other three in the second round.

Chairman MILLER. Thank you.

I would just like to chime in on this because I think this is an argument that is very often made. I think is demonstrates more a lack of capacity than a problem with the law. I mean, we had testimony here from an award-winning school—a complete turn-around in Southern Oregon, where they decided their road to success was to become a math academy and they decided they would do it on the backs of every other course that they teach.

They had the most engaged group of students I had ever seen at the elementary level. They all had to play an instrument. They all had to understand the mathematics of music. They all had to understand the mathematics of history and the size of ships and the depths of the oceans and the distance between the continents. They worked it out.

But you know what? You had to have teachers that had capacity so that they can multi-task those subject matters. If the teacher is a page ahead, there is no chance that that is going to happen. So what you want is simplicity, separation, drill and kill. There is nothing in the law that requires that.

In fact, I think we are starting to see the emergence of those who are in fact turning around schools are doing interdisciplinary studies. They are doing collaborative learning. They are reaching across classrooms to bring in these other subject matters to demonstrate the mathematics in that. We had the Mickelson ad of the golf swing—one of the most amazing graphics that played over and over and over. It told me I am never going to be able to hit that ball straight, but you know, that is depressing. [Laughter.]

So I think it is out there, but it requires serious professional development skills and talent. Those who cave in, those who shrink—again, there is no requirement under federal law that you do that,

but it is because I think there is a question of whether they have the capacity to differentiate and develop this.

I saw it on Indian reservations where math was used to explain the history and the natural resources of that, and engaged those students. So I just don't want this to become that somehow this is what the law requires. It simply doesn't.

Who is next here? Mr. Hare?

Mr. HARE. Thank you, Mr. Chairman.

I am going to have two questions here, one for Dr. Wolf and then maybe one for the panel. In my congressional district, I have a lot of rural areas, a lot of rural schools. The studies show students who take these challenging courses are much more likely to succeed in college and possess skills necessary for the workplace, but rural schools don't have and don't offer as many of these advanced courses.

I would like to know how can the teaching and learning of math in rural schools be improved through the integration of technology? I know you might have touched on that a bit with my friend, Congresswoman Woolsey, but as you know, I am very interested in this whole issue because in my district, as I said, I have so many rural schools. You would be surprised that people who live in Chicago or larger cities don't think we have problems, but it is all the same. It is not. Our young kids in rural communities need a lot of attention, too, so maybe you could help me with that one.

Ms. WOLF. Sure. I think there are two areas where this really comes into play. One is providing access to rigor and access to these opportunities. We see many, many states across the country utilizing online courses. They need to be high quality. They need to be interactive. They need to do all the things we know are about good education. We are seeing those emerge and there are those.

So access to those kinds of courses I think make a huge difference for kids, especially when encouraged. There are things that need to be in place to make that happen. I know that, and there are policies that make it easier. So I encourage you to look at that. Can it be taught by a teacher from another state? Those kinds of things definitely make a difference.

The other piece that I see making a tremendous opportunity, especially when we look at rural areas, is what technology can do for professional development. I taught only 12 years ago, but I did do the 2-hour workshops and I worked kind of in a box and I didn't have those mentors and those online opportunities. What we know now is that through online cadres and through cohorts of teachers in online courses, teachers can constantly be connected with one another and share lesson plans and share what works.

I think with math in particular in rural areas, we are finding that so many teachers have partners. We are the state that used videoconferencing so teachers of the same type of subject could watch over time what it looked like when it happened to another one. And you know what happened? Teachers changed what they were doing because they had a peer there saying, hey, I think that is what works.

The last thing with professional development—because for me this is an area where I see technology playing such an important role—really is that opportunity to provide those rich resources that

bring the outside world in. Whether it is the basis of Project Learning or it is allowing kids to use interactive math tools that make things come to life, we see all that working. I would love to share with you more details just on some of those projects because I think there is a tremendous amount of professional development and the access to rigor.

Mr. HARE. If you would be willing, doctor, to maybe get a hold of my office, we could talk about that, because I really think that is very important, particularly for rural areas. I thank you for that.

Ms. WOLF. Thank you.

Mr. HARE. Let me just ask the panel, what is being done to ensure that preschool-age children arrive at school ready to excel in math? What programs are out there? How can we, or how can all of us, promote and support early childhood education? I would think the sooner the better here. I am just interested in your thoughts on preschool children and what we need to be doing, or maybe what we are not doing that we should be doing.

Mr. FENNELL. Let me just start.

Mr. HARE. Sure.

Mr. FENNELL. The panel really had some strong recommendations there. For one thing, we know that young children come to school with a lot of mathematics understanding. So there is a starting place that has already begun. What we also know, sort of tragically, is that far too many young children don't have the kinds of experiences I just alluded to.

There is research out there that is beginning to show that when we provide parents and other caregivers with the kind of support necessary to have the conversation at home, have the conversation, frankly, anywhere about numbers, about other mathematical relationships, that you can begin to close that gap many of us talk about.

So it is a tremendous area to think about as a starting point. One of the things that we have to do, to do all of what schools are now supposed to do, is to engage far more directly, far more frequently parents and other caregivers in this process. This is not solely the job of the classroom teacher. This is not solely the job of the local schools. So the area that you cite is an area of tremendous promise, as well as need.

Ms. SLOVER. One leverage point that states have is to simply require that students go to pre-K. Many states don't require that and leave that up to local jurisdictions to decide, and in many local jurisdictions there is not enough money for all kids. It is optional, et cetera.

So one leverage states have is to make it a requirement. And then if they do, it would be important for them to define what kids should know and be able to do by the time they leave pre-K so that the consistency in what schools are offering is there. So that, you know, kids are getting a quality education no matter where they are going to school.

Mr. HARE. Thank you.

Thank you, Mr. Chairman.

Chairman MILLER. Thank you.

Mr. Scott?

Mr. SCOTT. Thank you, Mr. Chairman.

I thank all of our witnesses for their testimony.

Dr. Fennell, you talked about cultural values. One of our cultural values is the idea that we are going to maintain most of the control of education in 15,000 different school boards. As a member of the National Mathematics Advisory Panel, can you tell us whether it makes any sense to try to have more national standards, rather than have 15,000 different standards?

Mr. FENNELL. I guess I probably shouldn't share with you that to one of our early panel members, I suggested exactly that, that we consider national standards. And somebody spoke up about as quickly as one could and said that would take an act of Congress. I guess maybe I am talking to the right audience. [Laughter.]

In all fairness, I get the notion of local control. I understand very directly the need for local school districts, states and so forth, to have that sort of autonomy, as well as authority. Having said that, I think that there is a need for all children to have a deep understanding of particular mathematics before they enter certain levels of their education.

I would love to see whether it is the critical foundations benchmarks or NCTM's focal points, or what have you, be at least a starting point for a voluntary national curriculum, or a voluntary set of must-haves, because to not have something like that is the splintering that you are referring to around perhaps the state of Virginia, certainly around the country.

Mr. SCOTT. Thank you.

Ms. SLOVER. Could I comment on that?

Mr. SCOTT. Sure.

Ms. SLOVER. Achieve does a lot of work with states. I think it is critically important that we agree on the common core and that all states are delivering that curriculum. I think we are very much in sync with the National Math Panel on that message and with NCTM.

I think from Achieve's perspective that work is already happening in states, so we would like to see that continue. More and more states are revising their standards. As they do that, they are both making them more focused, more coherent, and they are making sure that they have that common core so that one byproduct of all the work that the American Diploma Project states are doing is that standards are becoming better, number one, but also more alike from state to state.

Not exactly alike. There are still some state differences, but I think there is general agreement on what is most important for kids to know. So it is bubbling up from the states that as they revise their standards over time, the standards are becoming much more consistent and focused around the same set of core issues.

Mr. SCOTT. But we would need to kind of encourage the national standard. If everybody has the different standard, you can't get there.

Ms. SLOVER. That is true, and yet if they have the same content in their standards, they are getting to that national consistency without having something federally mandated from them. If they use mechanisms like tests that they share, there is a way to check on their progress to make sure that kids are learning what is in those standards.

Mr. SCOTT. Thank you.

Dr. Haver, the mathematics specialists—I noticed that they have to be specialists both in mathematics and in teaching. Is it important that they have both content and good teaching abilities?

Mr. HAVER. Right. And what the specialists can do is to work with teachers in the schools to develop both of those skills—the teachers that they work with to develop a better understanding of the mathematics that they are teaching so that it is not just a bunch of rules they tell people to follow, and that they have ways that are effective, and effective to teach.

This professional development takes place in the schools. The specialists work with the teachers in the schools. They work as they co-plan their lessons with them. They perhaps co-teach, and they develop these teaching skills and the knowledge within the teachers of what they are teaching.

Mr. SCOTT. Does the specialist—is that a classroom teacher that has this as an extra duty? Or is this all they do?

Mr. HAVER. This is all they do. Their job is to provide in-school professional development ongoing.

Mr. SCOTT. Do you find that they handle more than one school?

Mr. HAVER. Typically, as I say, there are about 400 such places in schools in Virginia, typically they are one school, grades K through five. They will have weekly meetings with the kindergarten teacher, with the first-grade teachers, with the second-grade teachers. Of course, in some rural areas, they would be shared between schools, when the schools are smaller with less teachers.

Mr. SCOTT. Now, is the specialist paid more than other teachers?

Mr. HAVER. No. In many school systems, they have an extra month time in the summer and get that extra money, but typically it is a teaching position.

Mr. SCOTT. Thank you, Mr. Chairman.

Chairman MILLER. Should it be a teaching position?

Mr. HAVER. Yes. They are teachers.

Chairman MILLER. You wouldn't draw a distinction between them as an additional resource person? You didn't in Virginia.

Mr. HAVER. Our model has been that they are not administrators. They are not supervisors. They are teachers. They work with their peers. They help. In elementary school, a third-grade teacher has to know all these other important things—reading, arts, social studies. But what the math specialist brings is this deeper knowledge of mathematics and effective ways that work and develop these abilities in all the teachers in the schools.

Mr. SCOTT. But they don't get paid more?

Mr. HAVER. Well, in Virginia there is a certification to be a math specialist, and that comes with a master's degree. Because of the degree, they get higher.

I would like to add one other thing about what the federal government can and has done, and express our appreciation for the support we receive from the National Science Foundation and the NSP program, both in the Department of Education and the National Science Foundation.

We can get support in Virginia to help pay for these teachers to have these positions to be there, but to do the research about whether or not this work, having these specialists, makes any dif-

ference or not, it is harder to get the state government to do that. This research of this nature of understanding what makes a difference and what people can learn is something that can be used by all states. It is not just something in one state.

I think that is a clear national responsibility, just like in health, where we don't expect each state to come up with its own methods to cure cancer. I think we can't expect each state to determine which methods are most effective for teaching.

Chairman MILLER. Thank you.

You are welcome to take seats at the table there. You are welcome to come up here and sit in these empty chairs if you want, but you don't get to ask any questions. [Laughter.]

Because Mr. Holt would be very upset.

Mr. Holt is recognized for 5 minutes.

We are in a hearing on teaching math in America.

Mr. Holt?

Mr. HOLT. It looks like some of our subject matter is here.

Thank you, Mr. Chairman.

I thank the witnesses for good testimony.

I particularly appreciate the line that there is no math gene, but I would also like to suggest that we not slip into thinking, and we did a few minutes ago, that there is a teaching gene. I served on the Glenn Commission, now 6 or 8 years ago, whenever it was, with good recommendations based on the principle that, yes, Before It Is Too Late, is a title that is not yet overtaken by time, I think.

But a principal point we made was that through professional development, good teachers can be developed. So just as no one should be told that she or he is incapable of learning math, similarly we shouldn't give up on teachers. There are just not enough genius teachers out there to fill the need.

I certainly liked your testimony about why we need math to avoid fallacious thinking and to make sense of the world. We, among our colleagues and our staff, do constantly see the problems of poor understanding of statistics. We see it out in the country at large—inability to make order of magnitude estimates, clunky computation, and so forth.

But here, we are extolling quantification and why we need this for everyone, and yet what we are talking about today we are unwilling to quantify. What is most striking about the report of the Foundation for Success of the National Mathematics Advisory Panel are phrases such as we need methodologically rigorous scientific research. Basic research is necessary.

Research does not permit detailed conclusions. Very few studies were identified that probed the effectiveness of mathematics specialists. Research is smaller and less consistent than that which would be necessary. The body of high-quality studies on this topic is small. And yet we are making recommendations.

It seems to me the recommendation that we need to make is we have to spend some billions of dollars in educational research. We are spending $100 billion roughly in teacher salaries. We are not spending a tiny fraction of that in the research that is necessary for us to understand. We can avoid that because each of us is an expert on teaching, because each of us was a student. But if we will listen to what we are talking about here today, it seems to me we

will be drawn irresistibly to making a major commitment to research.

So my question for you is, where should that be? If we are going to spend hundreds of millions of dollars in research so that we can quantify and understand what we say needs to be done, where should it be spent? Should it be the NSF? Should it be the Department of Education? Should it be NCTM? Who is going to do it?

Let me start with Dr. Fennell please.

Mr. FENNELL. What a great catch on your part, because in fact the charge of the panel was to look at the research that is driving the field. What many of the task groups found was there isn't much. So were I to target where dollars ought to be spent, they would probably go in the following areas.

We looked at the issue of curriculum focus and coherence. There is no research out there on that, and that is going to be a decision of what we decide relative to important mathematics for our culture. That is not a research-driven area. But the issue that you mentioned, at least one of them, is. And that is what do we know about teacher background? What do we know about what works in professional development? What do we know about alternative teacher certification versus what students might receive at Rutgers in your state or wherever? That research is dying to be done by colleges of education, by other people who prepare teachers at virtually every level.

Similarly, we couldn't find a level of reliable research we might like on emerging technology. We have been using graphs and calculators in high school classrooms since, frankly, Texas Instruments and Casio figured out a way to do that. We don't have the research that talks about the impact of that on learning algebra, or frankly learning other higher-level mathematics.

What about the research of distance learning as a technological vehicle? What about the research on particular materials in classrooms? We need, this culture of ours needs, to be more firmly grounded in research, particularly as technology emerges seemingly nightly, for us to grab hold of.

So I couldn't agree with you more with regard to teacher background, with regard to instructional strategies. We know a lot about learning the subject. In fact, that aspect of the report was stronger than some others, but you can go through some of the areas that you cite.

We see, by the way, the notion of a math specialist as a very promising practice, but only went down the path where we did have some research. The work of Bill Haver and his project and others kind of popping up around the country gives us promise, but we need to collect that data, look at it very carefully, before we say everybody ought to think about math specialists, everybody ought to think about calculators or what have you.

Mr. HAVER. Could I add something to that?

Mr. HOLT. With the chairman's permission.

Mr. HAVER. That kind of research is very expensive. We are very fortunate to have a grant from the National Science Foundation that permits this research to go on, to get the kind of treatment and control school thing that we have going on extending over a 6-year period of time, of having the school systems agree that they

are not going to assign a math specialist to a school even if the parents are upset that the school next door has a math specialist as part of the study.

This is a big project that takes a lot of money. I think something that I hope is considered is that it is better to fund serious expensive programs that are going to provide real answers to questions, than a whole bunch of little things, each with its own little small evaluation piece of it. You don't learn anything from that.

Chairman MILLER. Well, I am not going to do the math here, but we would start by dividing it by 100,000 schools. So it is a big study, but——

Mr. HAVER. Yes, but we can't have each school do the study.

Chairman MILLER. Right.

Mr. HAVER. We have to determine who is best qualified to do it, and to conduct it and to get real answers to real problems.

Chairman MILLER. Mr. Hinojosa?

Mr. HINOJOSA. Thank you, Mr. Chairman and Ranking Member Buck McKeon for having this congressional hearing. I find it to be extremely interesting and one that I think we need to have a second and third round of questions.

I want to say that in following up with what Congresswoman Woolsey said about having a complete program for children to have art and sports and all that, I believe is very important and possible. I went to visit here in Northern Virginia the Thomas Jefferson Math and Science Academy because they were producing about 40 National Merit scholars, and I wanted to know how they could do it.

To my surprise, they had a program that was very rigorous, but included theater, debate, chess, sports, band—everything. I asked the young juniors and seniors with whom we spoke how they could do that. They did say that it was a longer day than most of the public schools. I said, well, give me just one example of a day, an average day here at Thomas Jefferson. The young woman said, I get up at 6:00 in the morning, and I go to bed probably about midnight, but I go to school by 7:00 or 7:30, and I don't get home until after the extracurricular activities, and it might be as late as 7:00 or 8:00 o'clock at night.

To my surprise in seeing their school, they had wonderful science laboratories. They had lots of teachers with master's degrees and some with Ph.D.s. It was just a place where you could not get a job as a teacher because teachers didn't want to leave. They didn't have any turnover rate. I found out that they had diversity. They had lots of girls. They had Hispanic, African American, Asian American.

So the myth that children of minority families can't learn is indeed a myth. It is that type of a program, and maybe Dr. Haver said it best when he said that research can be very expensive, but some of these schools can also be very expensive. So it is challenging for Congress and for the state legislatures to be able to create such an environment.

So I am going to ask my first question to Dr. Wanda Staggers, because I have a great deal of interest of being a voice for minority students, for girls and minority children, African American, Hispanic, Asian American, because it seems that our children have

less opportunities to be in an environment as I just described, but when they are placed in that environment, they perform very well.

So my question to you is can you tell us more about "It Is a Girl Thing?" Did you experience barriers to pursuing math and related fields in your career? And how can we encourage more African American, Hispanic American, Asian American children to pursue careers in STEM fields?

Ms. STAGGERS. For myself, I was directed into being a math teacher in 1972. I was never told anything about engineering, and I think it was because I was a female and maybe a minority. My guidance counselor was an older man, and he never suggested that I could be an engineer.

Since that time, I am now enrolled in an associate program in engineering because I am determined that I am going to hold a degree in engineering.

Mr. HINOJOSA. Good for you.

Ms. STAGGERS. Because of my determination, I don't want that to happen to other young females or minorities. So a couple of years ago, I started getting some grant money to offer summer programs. The biggest problem we have with our summer programs is they were girl's camps, and we would bring them onto the campus and introduce them to technology, is that they didn't have the transportation to get there during the summertime.

So I formed a partnership with Clemson University, with Serita Acker. She is the director of women in science and engineering. She is also working to get females into the college level. So we decided we would form a pipeline starting at middle school. We got some grant funding from the Engineering Educational Foundation and from the American Association of University Women.

What we did differently is we now go into the middle schools during the school day, so that way the kids are already at school. It is open to any girl who wants to be in the program, and they don't have to worry about transportation. We visit each of three middle schools in our district once a month. What we do is Serita has two female engineering students from Clemson University who design a lesson for the kids to carry out, and they come with us to the middle school and they teach them about chemical engineering, industrial engineering, biomedical, electrical.

So each time we go into the schools, we take a hands-on activity that those girls can get excited about. With some of the funding that we have left, we are going to offer a 2-week summer camp this summer. That one is funded by the Society of Manufacturing Engineers, and we are going to send one girl from each one of the middle schools to the WISE summer camp. That is about $650 a girl. We are trying to get funding from wherever we can to introduce these girls to engineering.

Mr. HINOJOSA. Thank you for that wonderful answer.

Mr. Chairman, I want to welcome a group that comes from my congressional district. These young ladies and their professors come from the All American city of Edinburg, Texas. That happens to be where I have my congressional district office. They have come to learn a little bit more about Congress and how it works. They represent an institute that is very interested in helping us with

HESTEC, our Hispanic Engineering Science Technology program that I have brought to Congress.

We are going to have 10 models in 2008 and 10 more models in 2009. It describes everything that you have said, Dr. Staggers—just creating an opportunity to tell students that they can be a scientist, an engineer, a mathematician, and then put them through the program that you just described. So thank you for coming to be with us and to be here in Washington.

Mr. WU. If the gentleman would yield just for a moment.

Mr. HINOJOSA. Yes.

Mr. WU. I very much appreciate the Texan's presence here. Although we very much appreciate Mr. Keller holding the fort, we do hope that there are a few Democrats left in Texas and the fact that they are sitting on the Republican side is not an indicator of their——

Mr. HINOJOSA. There were so many, David, that we had to——

[Laughter.]

Chairman MILLER. The chair reclaims the time of the committee here. We want to welcome you very much and hope you enjoy your experience here. Thank you for joining us.

Mr. CASTELLANI. Mr. Chairman, may I make just a very brief comment on what Mr. Hinojosa just said?

Chairman MILLER. Sure.

Mr. CASTELLANI. It is indeed a math problem that business recognizes. This is a very simple part of the problem. Where the majority of the graduates of universities will be women for the foreseeable future, where a substantial portion will be African American and Hispanic, if we don't find ways to attract those people to come into the STEM disciplines and become engineers and scientists for us in industry, then we cannot meet the goal of 400,000 a year.

Mr. HINOJOSA. You are a courageous genius to be able to observe that.

Chairman MILLER. Yes, will you guys go out in the anteroom? [Laughter.]

Mr. Tierney?

Mr. TIERNEY. Thank you. It segues into what my line of questioning was going to be.

I want to thank all of you, first of all, for your testimony. This is very enlightening. It shows me clearly why I didn't proceed further in math, and I am identifying all the issues now, a little late.

But Mr. Castellani, corporations are oftentimes criticized for that relentless drive for the bottom line and people thinking that maybe the concept of corporate citizenship is suffering because of this real or perceived issue of having to have a return to your shareholders all the time and that takes paramount responsibility.

So my question to you really is what should we expect of industry in terms of improving teacher preparation and capabilities of that? And how do we motivate it? And how do we organize it?

Mr. CASTELLANI. Well, in fact it is a very good question, and the two are absolutely tied together, because the demands of our shareholders, many of whom are pension funds—in fact, almost two-thirds are institutional shareholders—are that we provide better returns.

We know we cannot provide better returns unless we can compete, and we know we can't compete and succeed in the international marketplace unless we have more qualified employees at all levels to be able to design, be able to manufacture, to be able to service, to be able to finance, to be able to distribute the products that we now find in every corner of the world.

So what you see is a tremendous emphasis on corporate philanthropy in education. It is the biggest single focus of our members, and I think it is across all corporations. In fact, the numbers are difficult to add all up, but it is by our best guess somewhere between $600 million and $1 billion a year.

The motivation is a very simple one. If we do not have high-quality graduates from our high schools, our colleges, our community colleges, then we will not be able to compete and meet our shareholder expectations.

Mr. TIERNEY. When you direct resources in that way, do you get any push-back from people who may think that the quarterly bottom line could be bigger if you weren't putting resources over there? And is there any need for legislation or some notion to resolve that liability issue?

Mr. CASTELLANI. No. You know, I think there are some people, but it is a very minority of investors who say it is not the role of corporations to be engaged in philanthropic activities. In fact, the preponderance of investors recognize that it is the role of corporate leadership to make sure that we have the resources to sustain our companies in the future, and this is the most critical resource.

Mr. TIERNEY. So here is the next question. I would open this to the panel. How do we organize that? I know that there are a lot of different philanthropic efforts out there, a lot of corporations in my district and like that. Are we getting the best bang for our buck as they all go off individually and do what they think is the notion of what needs to be done? How do we organize it in some way constructively that we focus it right in on, say, this math problem of getting those teachers? Who does that and how do we do it?

Mr. CASTELLANI. That is a very good question. We organize on an ad hoc basis. Achieve is one good example of how we can organize to share best practices and to share experiences. The National Math and Science Initiative is another way to do that.

One of the things that is a shortcoming, and we have our members get together themselves in our own initiative on education in the workforce is we don't share enough information about the success of the programs that we support with each other.

In fact, last year just before he retired, Herb Allison, the CEO of TIAA-CREF, convened a number of our members in New York and, together with the Business Higher Education Forum, we are beginning an effort to share those experiences so that we know among our own community what works and what doesn't work and focus better on those things that do work.

Mr. TIERNEY. Does anybody else on the panel—Ms. Slover, do you want to address that? How is this working in this particular math issue? Can it be better organized and how?

Ms. SLOVER. Thank you. Well, Achieve does have engagement with business. We have business leaders on our board.

Mr. TIERNEY. And Massachusetts participates.

Ms. SLOVER. Yes. And so I think there are several ways in for business leaders, and many business leaders choose to act on the local level because that is where they get the most recognition. We heard a little bit earlier about two companies, TI and ExxonMobil, and there are numerous companies, particularly those on our board who I should acknowledge, that do work at the national level.

So I think it is finding for each business and business leader the way that they are going to connect with these issues. Achieve has some tools. We have a website called BizTools for Schools that really engaged business leaders in how they can act on many different levels, particularly around math and science.

Mr. TIERNEY. I just think we are coming to more and more of a realization, and I think the chairman has been good at this, that we can't do it alone and that business has such a high stake in this that we really need to martial our resources. I am just wondering if we are not letting some of that leak away in the ad hoc approach, and if there isn't a better way to martial it so that we are not asking unfairly for more than ought to be asked for, but on the other hand we are getting all that we can get, and focusing where it needs to be addressed, where the needs are greatest.

Ms. SLOVER. Right, so you can avoid the fatigue of just throwing money at a problem that always seems to get bigger. I think actually the Business Roundtable does a good job of really coalescing the business groups around a particular issue, identifying the important issues, and then helping them move en masse towards a solution.

Mr. TIERNEY. Thank you, Mr. Chairman.

Chairman MILLER. Thank you.

Mr. Wu?

Mr. WU. Thank you, Mr. Chairman.

Professor Haver, I apologize. I came in right in the middle of your answer. We frequently have multiple committee assignments, all simultaneously holding their hearings. But were you analogizing curriculum development to federally sponsored scientific research in other fields?

Mr. HAVER. Yes. I think as——

Mr. WU. Thank you. I just wanted to depart from there. I am a little concerned about that analogy because research and biology or physics or other such things, that holds kind of a not quite universal, but a more global truth to it, if you will. Whereas curriculum has traditionally in our society in America been left to local development.

It is not because there aren't universal rules of mathematics, but it is because there are some concerns about how such things should be taught at a local level. Instead of French education, where the French education minister in Paris on any given day knows what book a third-grader and what page a third-grader is on, but that is not true of the American education system for cultural and historic reasons. I am deeply concerned about an advocacy for a federal development of curriculum in any given subject.

Would you care to respond to that?

Mr. HAVER. Yes. I think there is a difference between finding out things, for instance the math specialists that we have that was putting a math specialist in a school with the job of professionally

developing all the teachers and developing a math program. Does that make a difference in student performance? That is the research that we are conducting.

When we receive support from the federal government, the National Science Foundation, for this, nobody said that if we find out that this makes a real difference, that the federal government is going to make every school system do it.

Mr. WU. So you are not advocating for one particular mathematics curriculum.

Mr. FENNELL. The word "curriculum" is being used here inappropriately.

Mr. WU. Dr. Fennell, would you care to jump in?

Mr. FENNELL. Yes. I mean, what Bill was responding to was his initiative with regard to the preparing and the impact of mathematics specialists at the elementary level. It wasn't a response to specific curriculum materials used anywhere.

Mr. WU. That is reassuring. I was taught mathematics one particular way. It was the new math. It was a break from the past. It didn't scar me for life. It was okay. My kids, who are 8 and 10 right now, are being taught math a different way. It is very different from the way that I was taught math. I am not sure that it is the right way or the wrong way. I would prefer to leave those decisions to teachers and local decision-making, especially in light of the gaps in research which Mr. Holt pointed out earlier.

Mr. HAVER. That is what I was speaking to, the need for that research so that the individual school systems and states can make the decisions based on facts, not on opinion.

Mr. WU. Very good. Then you have educated me. Thank you very much.

I yield back the balance of my time.

Chairman MILLER. Mrs. Davis?

Mrs. DAVIS OF CALIFORNIA. Thank you, Mr. Chairman.

I am sorry I had to leave. I got all of your testimony earlier, and you might have covered this, but I know that you were talking about Massachusetts when I left, and the scattershot versus really being much more focused, and certainly the research from other countries has demonstrated that.

To what extent do you think our textbook selections drive these decisions? What role do you think Congress might play in trying to mitigate that problem? It seems to me that it is a real one and I wonder if you could comment on that with some of your suggestions.

Mr. FENNELL. Yes. One of the early meetings of the panel included an invitation to all of the major publishers of textbooks in this country. Our work caused us to get through virtually everything in print. One of the panelists has coined the phrase that American textbooks—and I love this phrase—are bloated. I have several grandchildren, and one of them is carrying back and forth to school a 738-page third-grade book. I am concerned about a hernia at age 8.

There is no good reason for books to be that bloated. But that market the publishers are reacting to, what the state standards are, and when you have 50 state standards that are frankly all

over the place, and you are trying to sell that book in an open territory in this country, that is how it looks.

Now, the publishers look us right in the eye and say, oh, you know what? We will change that. We are willing to change that when the states redefine their syllabi and so forth. And there are encouraging signs. I have seen books lose 200 pages in the last couple of years because the state, a major state that was either California or Texas, I forget which one, that sort of redesigned their curriculum framework so they have fewer objectives, then you have fewer pages.

And by the way, it is not just elementary school. I have looked at algebra books that have over 1,100 pages. You talk about hernia. So the notion of what is important in that book and how it maps to really important mathematics is a critical question. It is not just the state directors of mathematics and the framework people who are responsible. Textbook publishers have to be in this, and we need to push on that.

Mrs. DAVIS OF CALIFORNIA. Go ahead. I am sorry.

Ms. SLOVER. I just wanted to reinforce that. It is absolutely the case that the states need to take the first step in narrowing and focusing their set of standards, and then the next step is for the textbook publishers to follow suit. We have talked among the states that we work with, the 33 states in the American Diploma Project network, about having a sit-down, face-to-face meeting with those textbooks, including the National Council of Teachers of Mathematics in that conversation, to really make that point. We need help both ways to really cut that curriculum down and make those books a little more manageable for our kids to carry.

Mrs. DAVIS OF CALIFORNIA. Well, I wonder, too, if it goes, Dr. Staggers, to the teacher preparation as well, and training. Because I think in many ways teachers are asked to cover so much material, and so when they sit in a textbook meeting to try and decide on textbooks, they are impressed also with the length of the book, how much material is in the book, but not necessarily the depth because in some ways they haven't necessarily been schooled in that depth as well, unless they have been retrained and had that opportunity.

So I guess I am seeing that a lot of that plays in together. What else should we be looking for in this area?

Ms. STAGGERS. In many of our Project Lead The Way classrooms, we don't have class sets of textbooks. You can if you want, but I would rather have a collection of resource books, rather than 30 copies of the same book. I would rather take that money and put it into some type of technology, because the books become outdated so quickly.

We can use the Internet to find up-to-date information, and as I said, a collection of resource books. We can use authority figures on those topics. That is where I would rather invest my money. Now, if it is a subject area that is not going to change, then that may be different. But even math books, it doesn't change, but the photographs and things in the book and the type of references to the word problems in the book are no longer relevant to that generation. So sometimes it is better to have a smaller resource and be able to update it readily.

Ms. WOLF. If I may, can I add one thing as well? Is that okay?

I have been involved in a task force looking at the future of content, and all the major publishers have been there. We held hearings in Texas and in Florida, where we brought in teachers, district leaders, state leaders—people in the nitty-gritty of textbook adoption.

When you take a step back and you start to listen about what is possible, teachers do want to have some options to make decisions because they are in fact experts and they can have professional development. There are different possibilities, and textbooks are one key piece.

But as Dr. Staggers just alluded to, there are many different kinds of curriculum and opportunities, whether it is through digital or other resources that may play into what that content looks like. I do encourage all of us to talk about it in that way because sometimes the depth that has been referenced that we want to get to is much more possible, or that application of knowledge may come through in some of those digital content areas in a way that just the stand-alone textbook does not.

But again, if you look at what publishers put out there, there usually is a range. So I think in thinking about this in a new and creative way of what is it that we need to give our children the best content and give teachers that flexibility to utilize it to meet the needs of No Child Left Behind in those ways.

Thank you for letting me jump in.

Mrs. DAVIS OF CALIFORNIA. Yes. Thank you. And it is the exposure also, and I think the problem that you have cited earlier is that unfortunately not everybody has the same kind of exposure in teacher professionalism that you are talking about.

Thank you.

Chairman MILLER. The chair is recognized for a second round of questions here.

I think that Mrs. Davis opened up a very important discussion here. It goes to your testimony, Dr. Wolf. That is that you stated, or the pamphlet that you handed out states no industry or organization can remain competitive without comprehensive use of technology as a matter of course in its operations.

Schools are fighting mightily against that trend. We haven't seen any major institution in the world that has engaged the Internet without its architecture dramatically changing. In some industries, it has turned out to be a profit-killer because of the dramatic worldwide competition that it introduces. It has introduced massive efficiencies. It has introduced massive collaborations. It has introduced massive markets to people who were making jam in Pennsylvania and all of a sudden they are selling it all over the world. But schools are going to keep it out as long as they possibly can, apparently.

What I find amazing is that teachers of mathematics have not yet developed an open-source textbook that is available to teachers and they can take it. I visited an organization in Silicon Valley where the woman running the organization is developing the equivalent of the California textbooks with all the same writers, same editors and the rest of that, and you can have it any way you want. So you don't have to lug around a 12-pound textbook. You can have

it by CD. You can have it at home. You can download it. You can pick and choose. You can change the pictures. You can add in today's, and it is a Wikipedia approach to the world.

The basics of mathematics haven't changed very much. There has been new discovery, but there is a lot to be added in terms of the teaching of that. At some point, if we can't engage this, you know, that bridge, you don't have to build a bridge. You can do all of those studies with your students virtually, right? You can do it and you can load that bridge down and those trusses will eventually break or they won't, and they will have success or they won't.

The reluctance to engage the technology is just stunning to me when I see the opportunities. So if you talked about one of the students engaging in after-hours problem-solving and back-and-forth with students who wouldn't speak up in class, but were participating in those text sessions or e-mail sessions or whatever they were using at that time.

We went to a conference on technology and education by CUNY, with one of the founders of Sesame Street in New York last week. We listened to the creative director of Electronic Arts, which this month is most famous for Grand Theft Auto—$500 million bang in a week—but also for John Madden Football. He demonstrated there John Madden teaching mathematics.

The probability that if you match the linebacker head-on-head with a specific runner, what was the probability that that tackle would be made; what is the probability, according to the statistics, of that season that if you hit that running back at an angle, that that tackle would be made. This is what a generation of people did, as he pointed out, around baseball, before you had all the other entertainment.

Now, John Madden may not be the best mathematics teacher in the world, but there is a curriculum there for somebody in those discussions and those very applications of mathematics. I am just stunned that we would suffer a bad math teacher when we can import a good math teacher on the video. That doesn't mean that is the answer. It doesn't mean they don't need support systems, but that is the subject of another hearing and this will be back before the committee. I know you look forward to it. [Laughter.]

Dr. Haver, what do we know about—we have had reading specialists around longer than math specialists. I know in California, my father started a program called the Miller-Unruh Reading Teachers. Politicians got together and decided they should have extra reading resources. Most of them are gone now in the state over the last 30 years, but I always find it interesting that the wealthier districts never gave them up.

They are all gone from the poorer districts because of budget cuts, because if you lost them, you could never get them back. But parents in the wealthier districts have always scrambled to keep them. I just wondered, I don't know if there was any study, except that obviously somebody liked their participation and teachers rave about them, but we never had any hard studies on their effectiveness, or have we?

Mr. HAVER. In Virginia, most of the reading specialists until very recently have been involved with pulling out students out of a classroom that are having difficulty, and working with those stu-

dents. That hasn't been our model for the math specialists. The model there is for them to coach the teachers and team-teach with the teachers to change the way mathematics is taught in the whole school.

A very pleasant side effect of the work we have been doing with math specialists in Virginia is that the reading specialists are gravitating to that model more, too.

Chairman MILLER. You are building capacity with the teacher?

Mr. HAVER. That is right, getting the teachers so that they can do it. If a teacher doesn't know mathematics very well, they are going to have to just isolate it. They are going to have a difficult time integrating it into a study of geography or art or anything unless they can get help to do so. So that is what the math specialists do.

The reading specialists are in many of the schools that have the math specialists, and are working on developing that same capacity doing that same thing. That would be a very interesting question to see the impact of that, and whether it makes a difference. And no, I am not aware of any research along those lines.

Chairman MILLER. Thank you.

Mr. Keller?

Mr. KELLER. Thank you very much, Mr. Chairman.

I appreciate all the witnesses for being here. I am convinced of three things if we want to get more math majors. First, we have to reward good teachers and we have to get rid of bad math teachers. Second, we need more girls taking more math courses and become more math majors. And third, we have to give kids the realistic information about the career applications of mathematics.

If I can be specific on each three, and I will follow up with Dr. Fennell on merit. We have a teacher at one of our inner-city high schools who happens to be a basketball coach. He teaches advance placement calculus. His classroom is filled with low-income and minority kids who really kicked butt on the AP calculus class, the best rate in the whole county. He takes the poorest kids and they are all passing AP calculus classes.

I would love to be able to pay that guy more. On the flip side, if we have a horrible second-grade teacher who is incompetent after a couple of years, I don't care what the union says. We have to get rid of her or him, whoever it is. That is just some straight talk, and I am not going to ask you all the way into the controversial issues of local union stuff, but that is the truth, in my view.

Second, on gender, I will ask you about that. In this report, Dr. Fennell, I looked through it and it is pretty silent on the gender issues except when you get to pages 31 and 32: social, motivational and effective influences. Average gender differences are small or nonexistent. I assume you are talking about test scores, as opposed to the number of boys and girls taking mathematics and engineering courses. Is that correct?

Mr. FENNELL. Actually, that data does look at test scores, but I would claim that the issue of surrounding gender is much different than it was even 5 years ago. We have far more girls and young women majoring in mathematics in this country, doing more advanced calculus at the high school level, and on beyond calculus.

Mr. KELLER. If I looked at 100 students taking AP calculus at a typical public high school, what percentage would be girls versus boys?

Mr. FENNELL. Well, the gentleman just walked out, but the high school he mentioned in Northern Virginia probably would be 50/50 or even more favoring the girls, but it is going to depend on the area.

Mr. KELLER. I have not seen that anecdotally, I will tell you that, at all. I mean, no even close. I took advanced placement in calculus and there were no girls in the room. I took organic chemistry and physics in college and a very small percentage were——

Mr. FENNELL. That has turned around quite a bit.

Mr. KELLER. If I looked at the number of math majors and engineering majors at MIT today, do you think it would be a 50/50 split on gender?

Mr. FENNELL. No, not at those places, but at smaller places where there is more inclusive attitude toward all people achieving, you would probably see more.

Mr. KELLER. I think it is a flat-out problem. I think if you took the calculus class and test, and Dr. Staggers took the calculus test, I think you both would get fives and you both would get great, and I wouldn't see a difference in scores. But when you looked around the room, I think there would be more males and more boys taking the calculus class. I just have observed that, and I think we ought to get more girls taking it.

That leads me to my third thing. I think guidance counselors have to do a better job of telling these young girls and low-income kids, boys and girls, the consequences and the ramifications of taking math classes. I have a little girl. I have three little girls, but I have an 8-year-old little girl who does okay in math, and she tells me that she doesn't really like it. Her dream in life is to become a veterinarian.

I said, Christy, you are not going to be a veterinarian unless you can do trigonometry and physics. That is just the bottom line. And to do trigonometry and physics, you have to work your way up. I took a bunch of children from an inner-city school in eighth grade out to Lockheed Martin to meet with folks who design video games and simulators.

I said, how many of you like to play video games? And all the hands went up. How many of you would like to design video games and simulators? All their hands went up. How many of you know that you have to take 3 years of math classes and do trigonometry before you can get a job doing this? None of them knew that. We have got to make sure that these kids know the consequences of taking 3 years of math and science.

I will just give you one final example. I think nursing is a wonderful profession. Being a doctor is a wonderful profession. But I personally know, and I have friends of mine who are females who decided to be nurses, even though they are as smart as everybody else, because they didn't want to take calculus. Well, that is fine, but when you make that decision when you are 17 years old that you are going to be a nurse instead of a doctor because of calculus, well, 12 years from now when you in the neurosurgical suite and you are making $50,000, you are going to be handing the scalpel

to somebody making $900,000, all because you didn't want to take a trig class and no one told you that in high school.

Now, we have got to do a better job of guidance counselors telling these young ladies the consequences. Don't pretend like there are not consequences. There are. And encourage them to keep their options open by taking 3 years of math classes in high school.

Dr. Staggers, do you want to weigh in on that as both a mathematician and a female?

Ms. STAGGERS. I completely agree with you. I keep going back to Project Lead The Way. Part of their professional development model is to have training for counselors as well. So in their component, they not only train teachers, they train the counselors and the administrators. So the counselors know what to tell the students, because you are right: students don't know. Just as I said when I was in high school, I didn't even know what engineering was and no one offered to tell me, so I didn't know to ask. And I didn't have parents who were college-educated who would have told me.

So I agree with you totally. Maybe the teachers need to take on some of that responsibility as well, of being sure the students know the consequences of their choices.

Mr. KELLER. Thank you.

My time has expired, but maybe the chairman will let Ms. Slover respond.

Chairman MILLER. Does Ms. Slover have a comment?

Ms. SLOVER. Thank you so much.

I just wanted to jump in here, because Achieve has just recently completed some work that speaks to your question directly. We have to communicate better that the more math you learn, the more money you earn, and that the choices you make in high school have repercussions for a long time.

What students don't know or may not know is that even in professions that don't require a 4-year college degree, math is a requirement—you mentioned nursing, other health professionals like lab techs, aeronautics, manufacturing, construction, technology. We have just done a lot of research in the last 8 months about those professions and how mathematics is used every day on the job in those professions.

We have come out with several publications which I would be happy to share with you, congressman, that make the case in very simple, easy to follow language, for policymakers and for students and teachers that math is important, why it is important, and what the impact will be on their career choices. So I would like to share that with you afterwards.

Chairman MILLER. So you think even policymakers could follow this? [Laughter.]

Ms. SLOVER. I think so.

Chairman MILLER. Okay.

Mr. Hinojosa?

Mr. HINOJOSA. I want to say thank you for having a second round of questions. This one is directed to Mary Ann Wolf.

I want to say that, or rather ask, you mentioned that online professional development is a means to positively impact the practices of teachers, and ultimately increase student achievement. Can you

expand on that? How do you measure the impact that online professional development on teachers and students can be assessed?

Ms. WOLF. Thank you. I look more at professional development as needing to be ongoing and sustainable. There is a body of research that has been around for a while and continues to be looked at by Joyce and Showers that shows that a one-stop shot workshop has about a 5 percent change of a teacher implementing that in the classroom. I will tell you that I went to those workshops. I was all excited, as I believe you referenced, and then I had no time to go back and do any of it with my students.

But if you look at Joyce and Showers research over time, and you add mentoring and online communication and ways for teachers to connect and ultimately coaching and mentoring, there is a 90 percent chance that those teachers will change what they are going in the classroom. That is what I think we all want to do.

The reason I speak so highly of online professional development in this context is that for a lot of people there may not be that instructional coach in the school or maybe they are teaching in a subject area where there is no other calculus teacher in the state perhaps. So what online professional development does in education portals and those other ways is it provides access to those opportunities to connect teachers in a sustainable way, and that is what we do know that makes a difference.

So I think those rural areas, to some inner-city areas and other places, that just is a tremendous opportunity for more and more teachers. We look at Alabama that has great resources in place where they are connecting teachers and students with online development and resources, as is Arizona and many others.

So I really appreciate the question. I think we can do more to look at, and I think we are beginning to. eLearning Delaware has a program now directed directly at math where teachers can take three courses. One is actually developing those beginning algebra necessary skills even before kids get to algebra, and they are helping to teach that. So I think online professional development plays a key role in that ongoing and sustainable piece.

Mr. HINOJOSA. Thank you.

My next question goes to Dr. Fennell. I liked what I heard from you and Dr. Haver about the involvement of the private world, the profit-making businesses that are looking for a trained workforce and how much they are needed, because we can't do it alone. Certainly, the state legislatures throughout the country can't do it alone. So we need their participation, their involvement.

Tell us how it is being done in your states. I think, Dr. Haver, you come from Virginia. I think that with the examples, models that I have seen in Virginia, we need to better understand how to bring business and industry as partners, and to put in some of their treasures into this effort that is being made in math and science.

So I will start with you, Mr. Fennell.

Mr. FENNELL. Sure. I actually come from Maryland. While I can't immediately recall a business partnership, I am going to share with you a governmental partnership. The National Security Agency, NSA, works very directly with teachers in four or five counties surrounding the Baltimore and Annapolis area to provide profes-

sional development, to provide activities for children, and even competitions for kids. So there is an opportunity where an entity that is governmental in nature has found a way to reach out to connect with people who are in classrooms, as well as children, and showing them what can go on.

Mr. HINOJOSA. Where does the money come from and how long is the program?

Mr. FENNELL. This project has been going on for a long time. You can define a "long time" by sort of looking at me, probably 15 or 20 years that I am aware of. My guess it comes somehow from their budget, but I know that teachers in Anne Arundel County, Maryland, and Howard County, Maryland, and Baltimore County, Maryland have seen the fruits of that partnership.

Mr. HINOJOSA. You didn't mention any businesses coming into the partnership here. Have you all looked at that? Or do they partner for the schools?

Mr. HAVER. I would like to respond to that.

Mr. HINOJOSA. Dr. Haver?

Mr. HAVER. I am from Virginia, and have been talking here about the work we have been doing with math specialists over the last dozen years. We have had a very helpful partner in this work, ExxonMobil. They didn't just give us money. Their staff members work with us. They had a sustained interest in what we were doing over the 10 years. They didn't expect immediate results or to fix something and then get out. They made a long-term commitment to seeing what could be done to make a difference. I think that kind of support is much more valuable than just money.

Mr. HINOJOSA. In Texas, we have seen ExxonMobil start up a program that they call UTeach. It has been proven for the last 5 years at the University of Texas in Austin that it works, so now they are expanding it using that model through other states. But I am very pleased to see that they are producing very well prepared teachers like all of you talk about us trying to produce. They are certified to teach advanced placement and international baccalaureate programs, which then prepare the children to get into these STEM fields. I just wish that we had more companies doing that.

Thank you, Mr. Chairman.

Chairman MILLER. Thank you.

Let me just say, you have been very generous with your time. I don't know if any of you have a time problem. Feel free to leave if you have to.

We are going to have votes in about 10 minutes on the floor, so if you can stay, I would appreciate it. If you have to leave, not a problem.

Mr. Wu is recognized.

Mr. WU. Thank you, Mr. Chairman.

I want to re-open a topic which the gentlelady from San Diego, Susan Davis, opened about textbooks, and which the chairman followed up on about the adoption, or the failure of adoption, or new and innovative technologies. I know that none of you are necessarily textbook experts, or maybe you are, but I have been working on this textbook issue for about 5, 6, or 7 years, but in a college context and in a cost context.

I am stunned, Dr. Fennell, to hear that a third-grader would have a 730-some-odd-page textbook. I never had a textbook that long in college. There was a two-volume physics, the Halliday-Resnick was two volumes——

Chairman MILLER. Before you get to the third volume, get to the question. These people have been here a long time.

Mr. WU. I never had a textbook that long in medical school. It wasn't until law school that we had a textbook that long.

Does the thickness of that book not only weigh down the student? Is there a cost factor to the school or the school district for that textbook?

Mr. FENNELL. Absolutely. I think this is a very complex issue—the fact that published materials are trying to meet so many goals from so many states just to be, if you will, adopted. In some cases around this country, as some of you represent, you are in a state adoption state where you can only list so many books, so it becomes very competitive. In other places, it is open territory so the books frankly become more bloated in those areas.

And then the chairman mentioned Madden football or whatever, which I understand very well, by the way. But the piece is that every published program in elementary school mathematics and high school mathematics is available on the web, can be picked up, and frankly isn't used.

That is a teacher problem. That is a teacher acceptance problem. That is a teacher comfort problem. But that would sure save a whole lot of kids and folks lugging home stuff, but it is just one piece.

Mr. WU. Is there a failure to edit on the part of the textbook industry? You know, just throw it in; they will pay for it somehow?

Mr. FENNELL. I think it is also a need to be attractive, so maybe you have more pictures than you need. And you have problems that are particularly relevant to particular areas, as in programs that are trying to be tailored——

Mr. WU. Throw it all in and somebody will pay for it.

Mr. FENNELL. Yes, exactly. Yes. We have something for everybody here.

Mr. WU. Yes. So it creates a problem in this case for school districts.

Mr. FENNELL. Sure.

Mr. WU. And at higher education levels.

Mr. FENNELL. You allude to a very silent audience. You alluded to the college student audience who is paying an astronomical fee for that intro biology book that is going to be used only in that course for lots of them.

Mr. WU. They are not silent.

Mr. FENNELL. Good.

Mr. WU. We have received more mail on the textbook issue than any other issue that we worked on.

Mr. FENNELL. Good to hear.

Mr. WU. It is a very motivated, intelligent consumer group. They are not going to stand silent for this for very much longer. I think we have a piece in the higher education bill to try to address this for college students. It is interesting to hear that is an issue for K through 12, that somebody else, the taxpayer, is footing the bill.

Chairman MILLER. Mrs. Davis?

Mrs. DAVIS OF CALIFORNIA. Just really quickly, because I want you to be able to go.

Would you think of some way that we could incentivize a different approach as we work on No Child Left Behind? Is there some suggestion? Part of it would be research. I would love to see research that shows that the number of pages is directly not proportional to the amount of learning that takes place or something.

Mr. FENNELL. What about research that looked at student understanding? By "student understanding," I mean real understanding and proficiency and the ability to solve problems, if you will, critical foundations, really important mathematics that leads to algebra, as compared to such bloated programs where it is a scattershot approach to the subject.

Mrs. DAVIS OF CALIFORNIA. A look at those best practices, yes.

Chairman MILLER. Also, it is interesting that California history and Texas history looks different in an open-source textbook by high school history teachers who are Hispanic, than it does by the publishers. And Hispanic students seem to be more engaged and interested in that version of California history, which is every bit as accurate as the other one. So there are a lot of possibilities here.

I think that textbook publishers are about to encounter the next iteration of the web and its architecture. They are obviously deeply engaged in changing that architecture because they can see what is happening, when they measure the carbon footprint, and today when they do it, you can go to Kendall on Amazon and download your book in a minute and be on your way, but the student has to lug it around the neighborhood.

I would just like to go back to one question, and then we will let you go. This is for Dr. Wolf and whoever wants it, but the question you raised in the panel was about formative assessments. Obviously, this committee in No Child Left Behind is struggling with assessments. You found them to be helpful. It goes to the question of real-time feedback in terms of how I am asking the question.

Mr. FENNELL. The research in that area is pretty solid. It is solid solely at the elementary school level, and it essentially means the following. If you are the classroom teacher, you can use things like observation as you spot, if you will, how your students are doing on a topic. You can use quick end-of-class, if you will, maybe paper-pencil, maybe computer-driven assessments to not only monitor, but begin to kind of track the progress of how you are teaching, what you are teaching, and also your students.

It is a guiding effect, if you will, to the classroom teacher. At least in this panelist's opinion, it ought to be part of the repertoire of every classroom teacher. What is interesting to me is that the research that was located and found and which drove this recommendation is solely at the elementary school level. And yet, wouldn't middle school teachers, wouldn't high school teachers also benefit by using such guiding assessments to drive their practice?

Chairman MILLER. Ms. Wolf?

Ms. WOLF. Thank you. We also see the opportunity here as tremendous, and technology makes it possible. When I taught, I literally had one child who couldn't read in fifth grade, and I made 10 flash cards every night for that child, but I could individualize

for one student. What formative assessment is, especially when you consider using technology does, is it allows you to constantly know where kids are. It can look like a test, but can also be students using clickers where a teacher can see exactly who knows how to multiply that fraction, and yet the kids don't have to know who got it right, but she immediately knows, okay, I need this group to do this, this group to do that, or this student here. Or I need to start all over.

So there are many different ways to embed assessments over the course that constantly tells the teacher what they need to do, how to target, and I think ultimately it individualizes the instruction where we can meet the needs of all students. I think this is an area where a lot of different schools are really starting to look at, invest in having data teams. I think it is a place that encouraging can only help education for all kids.

Chairman MILLER. Dr. Haver, is there anywhere here in terms of feedback between the specialist, the teacher and outcomes in the class with formative testing?

Mr. HAVER. Absolutely. What we know for good instruction is that teachers have to think about what is going on in their classroom, what has happened today, and how that changes what happens tomorrow. It is another reason why we don't want to have 90 outcomes, because otherwise you have to move on to outcome 47 the next day once you have done 46, but to take advantage, to think about what has happened today and have that influence what happens tomorrow.

And yes, that kind of ongoing professional development for teachers, whether it is through the specialists in our model or whether it is through technology or whether it is through other sustained activities is necessary to bring about a change in how many students are successful. We have to develop the skills in the teachers to use a variety of tools to have their students learn in a way that is possible.

Ms. SLOVER. This may be obvious, but at the risk of being obvious, all of these things are so important and can be so useful as long as they are part of a coherent package. I think that Dr. Fennell and Dr. Wolf both were moving in that direction.

The formative assessment has to be aligned with the end-of-year assessment. It has to be aligned with the curriculum and the standards. And all of those things have to move along together, otherwise you will have kids going in all different directions. So forgive me for being obvious, but I thought that was worth stating.

I really appreciated what Dr. Fennell said about formative assessment also including just the teacher's interaction with students. So often, there are great technological solutions and we could spend a lot of money, but we also have to remember that part of the craft of teaching is to be able to assess your students every day in the classroom on what they are learning.

Chairman MILLER. Thank you very much.

Thank you all for your time and your testimony and your expertise. We are already plotting the second hearing up here, playing off of what you have said here today. So it has been very helpful.

I want to introduce into the record the testimony that was going to be presented by IBM had they participated.

[The information follows:]

Prepared Statement of IBM Corp.

Thank you for giving IBM the opportunity to convey our support for the National Math Advisory Panel's recommendations focused on raising expectations and standards for mathematics and improving teacher preparation and professional development for math teachers.

IBM, like many U.S.-headquartered companies, has become a globally integrated enterprise. As our economy becomes more globally integrated and competition becomes more fierce, there is growing recognition that innovation is the key to being able to effectively compete. Localities, states and nations are striving to become places where knowledge is generated and transformed into new commercial and societal value. They recognize that an innovative, knowledge-based society creates jobs, raises living standards and generates growth that competitors can't duplicate rapidly.

The question we face is what needs to be done to create an environment that will foster innovation? An important criterion will be the quality of education in order to equip students with the needed skills for the 21st century workforce. Mathematics is a critical skill in this equation.

A report recently released by the U.S. Department of Labor suggests that over the next 10 years, the need for technical people in this country is going to grow not by 30 percent, but 50 percent! While the demand for these jobs is increasing, the supply of talented workers isn't keeping pace. A skilled and talented workforce is a fundamental requirement to attract investment, foster real wealth creation and spur innovation in this country. It is critical for our continued competitiveness.

We are firm believers in the need to build the base of scientists and engineers and prepare the next generation of innovators. It is clear that if we are not going to have a constant flow of talent in science and engineering, we concur with the report's recommendation that we need to focus on the earliest stages in the K-12 pipeline. We also must ensure that students, from elementary school all the way through graduate school, are having the experiences that will generate enthusiasm about math and science and their ability to solve problems. They also must complete a rigorous and relevant curriculum so that they have the option of pursuing scientific, technical and multidisciplinary degrees in college or being adequately prepared to enter the 21st century workforce.

What needs to happen to prepare students to participate in a knowledge-based economy?

- First, our children need to be prepared to discover new things every day using a focused, coherent progression of mathematics learning;
- Schools should implement a mathematics curriculum in grades pre-K through 8 that is streamlined, with an emphasis on proficiency of key concepts;
- Students need reinforcement that achievement in mathematics comes from effort and isn't a skill that only results from an inherent talent.

Education is a part of IBM's DNA. We consistently play an active role in promoting and boosting education efforts at both national and local levels. For many decades, IBM has been one of the leading corporate contributors of funding, technology, and talent to non-profit organizations and educational institutions across the U.S. and around the world. We are committed to applying our skill and ability as an innovator against the challenges that exist in communities, addressing both education and societal concerns, and doing so in a fundamental and systemic way.

Why does IBM believe this is such a critical issue? The number of students taking advanced math and science classes and choosing engineering or technical careers is declining, yet the U.S. needs to grow its population of qualified, technically proficient workers in order to remain competitive.

This is a tall order and goes well beyond mastery of math and science skills and knowledge. Fundamentally, this requires a cadre of incredible math teachers in our schools, teachers who have the content expertise, the real world experience, an understanding of problem-based learning and the pedagogic practice to launch the next generation of innovators.

Studies have shown that over the next 10 years we need 2 million more K-12 teachers in this country; and, in addition, we need a quarter of a million math and science teachers in the next two years. Nearly 80 million baby boomers are going to leave the workforce some time soon. That's a huge problem for the U.S. In addition, over 40 percent of the same population of teachers are 50 years or older. This underscores the importance of this issue and the fact that our country must invest in improving and enhancing our education system.

Classroom teachers with strong knowledge about mathematics have a central role in math education. We agree that rigorously evaluated initiatives for attracting and appropriately preparing prospective teachers and evaluating and retaining teachers are critical to our students' success. The mathematics preparation of elementary and middle school teachers must be strengthened to improve teachers' effectiveness in the classroom. This includes: pre-service teacher education, early career mentoring and professional development.

As the report states, "The impact on students' mathematical learning is compounded if students have a series of effective teachers. Teachers should understand how to provide clear models for solving a problem type using an array of examples, offer opportunities for extensive practice, encourage students to "think aloud," and give specific feedback."

IBM Initiatives

In 2006, IBM announced Transition to Teaching, our initiative to address the K-12 pipeline issues and encourage young people to enter science and engineering careers. IBM's leadership in school reform has grown steadily since we first launched Reinventing Education in 1994, a global program, working with more than 100,000 teachers. Our most recent partnerships with school districts focus almost exclusively on professional development because if we want great schools, we must have great teachers.

We established the Transition to Teaching initiative by leveraging our greatest asset—IBM employees. Of course, most IBMers have backgrounds in math and science, whether they are currently working in software development, research, consulting or management. IBMers are also great volunteers; more than 115,000 have signed up for volunteer assignments through our On Demand Community, contributing about 5 million hours of service. Moreover, the majority of IBMers who volunteer do so in a school, whether as one of the legions visiting schools for e-Week (engineering Week); showcasing IBM's new 3D internet multi-player game, Power Up, focused on solving problems related to energy and the environment; as one of our 8,000 eMentors providing online academic assistance to students; or one of those working with children in a Head Start or daycare program that has a KidSmart program. They also lead after-school programs for middle school students and coach high school students for science fair and robotics competitions through TryScience.org.

This is an issue that impacts us all, but we do need to have a targeted strategy that is appropriate and effective in each and every community. That's why this month, IBM hosted the America's Competitiveness Summit to focus attention on the specific challenges we face to maximize the talent in the Hispanic Community and encourage young people to prepare for and explore STEM careers.

These IBMers tell us repeatedly that they have a passion for education, young people and for giving back to the community. Recognizing that there is a national teacher shortage in math and science and that there is large group of IBM employees who are eager to continue being productive and contributing to their communities, we created the Transition to Teaching program. Transition to Teaching specifically targets our mature workers who are interested in a second career in teaching, providing guidance, support and funding to help them transition into teaching as their next career move.

Specifically, IBM provides each participant with up to $15,000 for tuition reimbursement and stipends during their time in the classroom. Each participant chooses his or her own teacher certification model, but we encourage colleges of education to develop flexible programming, involving both online course work and more traditional courses with flexible scheduling. The IBMers also participate in online mentoring, both while they are still working and going to school, and once they graduate and begin teaching. We have a special social networking site for them at www.ibm.com to enable them to share and learn from their experiences. Finally, we have designed a special leave of absence program that provides each participant to conduct up to a year of student teaching while they maintain their benefits.

Today, there are 100 IBMers participating in Transition to Teaching. IBM designed the Transition to Teaching program after a careful review of the research, the experience of second career teachers, best practices in teacher preparation and our own focus groups with IBMers. We have a few program essentials.

First, teachers must have a strong, in-depth background in the subject area. Our criteria focus on IBMers who already have a Bachelors degree or higher in a math or science discipline.

Second, we believe that IBMers need to learn the craft and skill of teaching, classroom management, and instructional practice to be effective. Thus, we are reimbursing their tuition costs for education preparation.

Finally, we believe that it is absolutely essential for an individual to have practical K-12 classroom experience, observe good teaching and then practice good teaching BEFORE taking responsibility for a class of children. Therefore, we provide support for them to do student or practice teaching. We know there is a huge gap between mastery of a subject and the ability to teach that subject to others. We owe it to our IBMers and to our students to give them all the preparation they need, and we have designed Transition to Teaching to meet that standard.

Transition to Teaching and similar efforts are not a panacea, but they are part of a unique and real solution to the math and science teacher shortage. IBM is proud to demonstrate our corporate commitment to implementing solutions to the math/science teacher problem in our country, and we are working with other companies to encourage them to adopt a similar model for their transitioning workforce.

In addition, we also continue to collaborate with individual colleges of education and national organizations to improve teacher preparation programs and develop new models; we strive to enhance the reputation of teaching as an option for math and science professionals; and we continue to drive a national discussion with Members of Congress and other influencers to develop solutions that will address the urgency of improving math education. We would welcome and strongly encourage other corporations to join us so that 100 become 100,000. In the final analysis, we would like this program to be implemented across the country.

Addressing the challenge of investing in math and science education, preparing teachers and exciting students are responsibilities not only of parents and businesses, but also of government. With Congress' overwhelming passage of the America COMPETES Act last year and its enactment into law, Congress demonstrated a partial commitment to the principles of advancing math and science education, as well as basic research in the physical sciences. The unfortunate reality is that the authorized programs in the COMPETES Act were not funded. This is a critical issue that must be addressed as soon as possible. We strongly encourage Congress to fulfill the promise of the COMPETES Act by appropriating the funding necessary to support both education and research. We need tangible results. Funding these programs will enable us to train math and science teachers; provide scholarships to keep students in these fields; enable graduates to seed our economy and push the frontiers of knowledge through university research; and promote diversity in STEM fields.

In conclusion, we believe that a national dialogue among math and science education stakeholders is needed. Public and private sector representatives, parents and teachers must be involved in developing stronger academic preparation for K-12 students to get them ready for STEM courses in college, focusing on improving teacher quality, curriculum quality and offering tutoring and mentoring services to students. Unless we capture more minds, more hearts, more souls and more passion for math and other STEM disciplines, the innovation leadership and global competitiveness of the United States will be extremely challenged, if not threatened, in the foreseeable future.

Chairman MILLER. Again, thank you so much.

With that, the committee will stand adjourned.

[The statement of Mr. Altmire follows:]

Prepared Statement of Hon. Jason Altmire, a Representative in Congress From the State of Pennsylvania

Thank you, Chairman Miller, for holding this important hearing on the National Mathematics Advisory Panel Report. This report adds critical new information about the state of math education in the United States. As I am sure we will hear today, we have a lot of work to do.

The average score of American students on the 2006 Program for International Student Assessment (PISA) was below that of 31 other countries. This is simply not acceptable. The 21st century economy is requiring increasing levels of technological and engineering understanding. The foundation for this understanding is math. In order for our nation to remain the preeminent economy in the world, it is critical that we provide every student with, at a minimum, a basic level of math literacy. Doing so will ensure that all students can fully participate in the 21st century economy and also allow many of these students to pursue careers that require deeper levels of mathematical understanding.

Thank you again, Mr. Chairman, for holding this hearing. I yield back the balance of my time.

[The statement of Mrs. McMorris Rodgers follows:]

Prepared Statement of Hon. Cathy McMorris Rodgers, a Representative in Congress From the State of Washington

Thank you Chairman Miller and Ranking Member McKeon. I thank the members of the National Mathematics Advisory Panel for being here today to report their findings and recommendations on math proficiency.

I would like to take this opportunity to stress the importance of quality math and science education in our schools to increase our nation's competitiveness in order to create a skilled, 21st century workforce. To meet the demands of an increasingly advanced, global market we must better train and equip our nation's workforce. A major area of concern in our nation's effort to remain competitive is the rate of improvement in mathematics achievement and the impact that our current lack of mathematics preparation has on the state and national economy.

This process must start at the education level, making sure students have adequate skills when entering the workforce. In order to facilitate economic growth, we need to work collaboratively with the education and business communities to ensure that students are receiving the necessary education, skills and training to be successful. I have been encouraged by the steps President Bush and Congress have made to strengthen math and science skills through the No Child Left Behind Act, the America COMPETES Act and most recently through the College Opportunity and Affordability Act. It is my priority to strengthen our nation's math and science in order to remain competitive through scholarships for these fields and the placement of content specialists to bring real world experience into classrooms.

However, we still have a long way to go when 1 in 3 of students do not from graduate high school. To make things worse, only half of these high school graduates are proficient in math and English. We must do better. Today, over half of China's undergraduate degrees are in math, science, technology and engineering. Yet, only 16 percent of American undergraduates pursue these fields.

If our country is to stay competitive, we need home grown engineers, scientists and mathematicians. In addition, women are playing an increasingly important role in key sectors of the economy and must have access to the opportunity to excel in mathematics.

As a Member of the Committee on Education and Labor, I am committed to ensuring that every child in America is afforded the highest quality education possible and that every worker in our country is free to pursue the American dream.

I look forward to hearing your findings today. Thank you.

[Whereupon, at 12:44 p.m., the committee was adjourned.]