



Testimony before the House Education and Labor Committee

**Innovation in Education through
Business and Education STEM Partnerships**

July 22, 2008

**Melendy Lovett
Senior Vice President and
President, Education Technology
Texas Instruments**

Chairman Miller, Ranking Member McKeon, thank you for the opportunity to testify today on the important topic of science, technology, engineering and math (STEM) education. Today, I am going to speak from two perspectives: as an officer of Texas Instruments which has a critical interest in the development of a pipeline of engineers and scientists and also as the President of TI's Education Technology business unit whose business is focused on math and science proficiency. My testimony will address TI's STEM workforce needs as well as our activities to advance STEM education. Then I will highlight MathForward, a promising program TI's Education Technology business has implemented to advance student achievement in algebra.

Texas Instruments (TI) has a 78-year history of innovation. While our products have changed many times over the years, we have always fundamentally been a company of engineers and scientists. Based in Dallas, TI is the world's third largest semiconductor company. Semiconductors are the enabling technology driving everything from computers, cell phones, MP3 players, GPS systems, HDTVs, automotive safety, and medical devices. TI develops chip technologies for new electronics that make the world smarter, healthier, safer, greener and more fun.

While semiconductors comprise 96% of TI's revenues, many people still associate TI with the calculator. Indeed, TI's Education Technology business is responsible for the other 4% of revenue, with products including graphing calculators for middle school and high school. TI's Education Technology business is focused on improving math achievement for all students by fostering quality instruction and learning in mathematics. Research provides the roadmap for the creation of all of our education technology products and programs and we conduct ongoing effectiveness studies for products deployed in classrooms.

TI'S FOCUS ON INNOVATION

American innovation is a top policy priority for TI. The key elements needed for the U.S. to sustain its technology leadership are: investing in basic research, welcoming the world's brightest minds, extending the R&D tax credit – and perhaps most importantly for the long-term – improving math and science education. We view these as

inter-related parts of an innovation ecosystem and our policy objectives and corporate citizenship focus heavily on these priorities. Many in the business community have become very passionate about this set of priorities and rightly so. It is our future.

Education is the highest priority for corporate philanthropy at TI. Each year, TI makes financial contributions totaling millions of dollars in grants and other gifts to schools, colleges and educational programs. To help foster our next generation of high-tech innovators, TI efforts have focused increasingly on STEM, particularly reaching out to women and under-represented minorities. TI's involvement in education places a heavy emphasis on student achievement, closing the achievement gap, and developing programs with measurable success that can be replicated elsewhere. I describe some of these programs later in my testimony

TI's former CEO, Tom Engibous, served as a corporate co-chair of the business coalition to pass No Child Left Behind (NCLB) and TI is a member of the Business Coalition for Student Achievement that calls for making science, technology, engineering and math (STEM) education, and readiness for college and the workplace priorities in NCLB reauthorization.

STEM WORKFORCE NEEDS

As a former Vice President of Human Resources at TI, I know first-hand about the math and science skills required at the company. TI hires employees with skills at different levels. Because of the continuing complexity of the semiconductor design process and other technological advances, we are expecting more from engineering graduates in terms of the breadth of their engineering coursework exposure and experiences at all levels of higher education – BS, MS, and Ph.D.

The semiconductor industry depends on electrical engineers to design and develop the latest chips. A bachelor's degree in electrical engineering requires three modules of calculus, differential equations, and linear algebra, and often additional coursework in probability/statistics and applied mathematics. For advanced degrees in electrical engineering, coursework is often required in Math Modeling, Statistics, and Linear Algebra.

In 2007, half of the master's degrees and 71% of the PhDs in electrical engineering from U.S. universities were awarded to foreign nationals. This is a source of great concern for TI both because the nation is not producing sufficient numbers of indigenous EEs but also because under current visa policies our ability to hire and retain the product of U.S. universities is limited. TI strongly supports the bipartisan legislation (H.R. 6039) co-sponsored by Reps. Lofgren and Cannon as well as Chairman Miller and Rep. Sanchez that would exempt U.S. advanced STEM degree recipients from the green card limitations. TI also supports two other employment-based measures to recapture unused visas (Lofgren-Sensenbrenner H.R. 5882) and eliminate country limits (Lofgren-Goodlatte H.R. 5921).

Semiconductor manufacturing has migrated from the era of placing a high value on manual dexterity on the assembly line to one of mental dexterity on the clean room floor.

A TI manufacturing specialist must have a basic knowledge of math and science skills, such as performing addition, subtraction, multiplication and division, calculating fractions, decimals, and percents without the use of a calculator.

Our technicians must have an associates' degree in semiconductor manufacturing technology and pass a comprehensive test that covers basic electronics, applied physics and basic chemistry. They must be able to apply mathematical formulas, perform basic algebraic functions, and in some jobs apply algebra, geometry or trigonometry functions.

Finding individuals with the right skills set, particularly at the engineering level is a challenge. This will soon be exacerbated as the baby boomer generation retires. This one demographic change is expected to reduce the U.S. science and engineering workforce by half. Meanwhile, the Bureau of Labor Statistics (BLS) projects that employment in science and engineering (S&E) occupations will grow 70 percent faster than the overall growth for all occupations. Mathematical literacy is critical for a range of occupations in today's economy.

We need to address student interest and skills in STEM at all stages of the pipeline, from K-12 through university and graduate-level. Strong math skills are a gating factor for majoring in science or engineering.

TI'S ACTIVITIES IN STEM EDUCATION

TI and the TI Foundation support a range of STEM education activities from elementary to graduate school designed to enhance student interest and achievement in these key disciplines. A few programs relevant to math are highlighted below:

I led the effort to establish the **Women of TI Fund**, which sponsors activities to close the gender gap in STEM fields. In early 2002, several senior women leaders at Texas Instruments formed the Women of TI Fund to expand math, science, and technology education for girls in elementary, middle, and high schools. The fund leverages personal contributions of TI executives with funds from the TI Foundation, TI corporate giving, and the Dallas Women's Foundation by providing targeted grants to achieve this goal.

The fund also supports girls taking and passing the AP tests in math, science and computer science courses. The good news is that girls are taking and passing AP calculus exams at roughly the same rate as boys. However, the largest gender gap appears in physics. The Fund and the TI Foundation have now sponsored nine summer AP physics camps in the Dallas area for girls to facilitate success in this subject. In 2007, 134 girls took the AP Physics exam, a 132% increase over year 2000. 43% of girls taking the AP Physics exams pass the test in 2007, a 290% increase over 2001. The Fund also supports counselor and teacher education on engineering careers to encourage girls to explore these fields.

TI became an early supporter of the **Advanced Placement Incentive Program**, designed to encourage students to take more rigorous college-level course work in high

school. It provides incentives to both teachers and students for their successes. As a result of the AP Incentive program operated in the Dallas Independent School District, the original 10 Dallas ISD Incentive Schools have seen the number of passing scores for all students in math and science grow 1,220 percent from pre-incentive program levels (from 71 students passing in 1995 to 937 passing in 2007).

TI has been a national sponsor of **MATHCOUNTS**, an exciting competition that gives thousands of seventh and eighth grade “mathletes” a chance to race against the clock to solve challenging mathematics problems. In addition to providing major funding, TI supplies the TI handheld technology required annually to support local, state and national MATHCOUNTS competitions. TI is also a sponsor of the International Mathematics Olympiad, an annual mathematics competition for high school students.

In 1999, in collaboration with Southern Methodist University (SMU), TI helped design a math and science-based engineering curriculum for high school students called the **Infinity Project**. The class uses devices such as MP3 players and cell phones to teach engineering concepts. Infinity is now offered in nearly 275 schools in 37 states and is showing impressive results in changing student attitudes toward engineering and technology disciplines.

The **TI Math Scholars** program at the University of North Texas Dallas Campus aims to add to the pool of qualified math educators by offering full scholarships with book stipend, to students pursuing their Bachelor of Arts degree in Mathematics with Secondary Certification at the UNT Dallas Campus. The students will teach in Dallas ISD or select neighboring school districts for a minimum of two years in return for this scholarship opportunity.

The TI Foundation’s **Innovations in Science, Technology, Engineering and Mathematics (STEM) Teacher Awards** were established to recognize instructors at the secondary level who are enhancing student achievement and increasing interest in high school classrooms in the Dallas, Plano and Richardson independent school districts (ISD). As STEM fellows, the teachers participate in a unique annual professional development day at TI’s facility designed to expose them to interesting, everyday uses of math and science in the technology business world. Recipients also each receive \$10,000, of which \$5,000 is directly awarded to the teacher. The other \$5,000 is to be used at the teacher’s discretion for professional development or instructional technology.

FINDING COMMON GROUND IN THE MATH WARS

Math competency is at the heart of TI’s Education Technology business. Research on student learning and effective teaching is central to our efforts. We recognized that before there could be agreement on what and when students learn key math concepts, a divisive issue in math education had to be addressed. The “Math Wars” over conceptual understanding versus computational fluency have long prevented progress on K-12 math curricula.

In 2004, Richard Schaar, formerly head of the Education Technology business at TI, and PhD mathematician, worked closely with experts from across the spectrum of views, specifically respected mathematicians such as Jim Milgram and Wilfred Schmidt, and well-known mathematics educators such as Deborah Ball, Joan Ferrini-Mundy, and Jeremy Kilpatrick on a project funded by the NSF through MAA, with support from the Department of Education and TI. In a paper entitled *Finding Common Ground* published in 2005, the group found key areas of agreement around areas in mathematics that have traditionally been in dispute between the two factions. The group agreed that students need to be able to:

- 1.) Perform basic number skills
- 2.) Reason about precisely defined objects and concepts
- 3.) Formulate and solve problems

TI Education Technology submitted extensive written comments to the Math Panel. Our submissions presented the *Finding Common Ground* work as well as lessons learned from TI's extensive engagement in education and related research. One of the key findings is the effectiveness of the "systems approach," meaning that elements in math education such as teacher content knowledge and professional development, aligned curriculum, research-based instructional and learning techniques, ongoing assessments, and administrative support must be addressed in a coherent, integrated way. There are no silver bullets in a single system element. The MathForward intervention that I will describe shortly embodies the systemic approach.

Dr. Schaar provided additional written and oral testimony, on the research around calculator use and on the MathForward program.

The *Finding Common Ground* work and related recommendations from the Math Panel provide a basis for moving forward to improve K-12 math teaching and learning. TI applauds the emphasis on rigorous research and building research capacity recommended by Math Panel.

ALGEBRA IS ESSENTIAL

The Math Panel report notes that many educational policy experts see algebra as a central concern. Drops in U.S. math achievement start in late middle school. The National Math Panel report recommends a strong grounding through Algebra II due to the high correlation with access to college, graduation from college, and income potential. Among African American and Hispanic students completing Algebra II, the disparity in college graduations rates with the overall student population is halved compared to those who do not complete Algebra II.

TI supports the Panel recommendations on the critical foundations for algebra (fluency with whole numbers and fractions and aspects of geometry and measurement) and the major topics of algebra (symbols and expressions, linear equations, quadratic equations, functions, algebra of polynomials, and combinatorics and finite probability).

Further, TI endorses the recommendation that all school districts prepare students to access an authentic algebra course by eighth grade.

MATHFORWARD

In 2005, TI developed and implemented MathForward, an algebra and algebra-readiness program grounded in research done by a prominent professor of education.¹ Our efforts embraced the NCLB view that interventions be research based and aligned to state standards. The intervention program has proven successful in significantly raising the passing rate and test scores of students who previously failed state math assessment tests.

MathForward was created with the intent of eliminating the achievement gap between African American and white students, and Hispanic and white students, in middle school mathematics. In the pilot Richardson school district, from 2004 to 2008, the gap for African American 7th graders versus all students on the Texas math exam closed from -24% to -8% and from -20% to -11% for 8th graders. For Hispanic students, the gap closed from -10% to -4% in 7th grade and from -16% to -4% in 8th grade. While it is critical to eliminate the gap, we designed MathForward with the intent to increase the learning opportunities for all students, and improve student achievement results for all students, regardless of ethnicity or socio-economic status.

The eight integrated components of the intervention include:

- Teacher training focused on content knowledge and using data to drive instruction
- Ongoing professional development
- Increased classroom learning time
- Common, aligned assessments and benchmarking tools to track student progress real-time
- Integration of technology to provide real-time feedback and enrich classroom instruction and assessment.
- Use of an accelerated curriculum
- Establishment of high expectations for all students
- Increased support of math teaching and learning from parents and school administrators

These elements are consistent with the National Math Panel's emphasis on algebra and recommendations on learning and instructional research and teacher content knowledge.

¹ Carnine, D. (2002) *The Ten Components of High Achieving, High Poverty Schools*. Unpublished manuscript. Eugene, OR: University of Oregon. Summary available from <http://www.tea.state.tx.us/math/TenComEffSch.htm>

Increased Teacher Content Knowledge

Participating teachers meet regularly with a mathematician or use online video modules to build content knowledge for curriculum lessons they will be teaching in the coming weeks. Teacher's content knowledge is assessed prior to the start of the program and at the conclusion using the University of Michigan's Content Knowledge for Teaching Mathematics measurements.

Ongoing Professional Development

At the beginning of the project, teachers are trained on the use of the extended classroom time, appropriate integration of technology, data driven decision making and setting high expectations, all in the practical context of daily math teaching.

Teachers are given a common, duty-free, planning time at least a few times a week. The time is used to plan lessons for the week, discuss teaching strategies, analyze student work, and discuss underlying math concepts. Coaches/Implementation Specialists participate regularly in these sessions to provide guidance and feedback.

Extended Learning Time

Schools implement the MathForward program in two block-scheduled mathematics class periods per day. The daily mathematics class is partitioned into three distinct sections: daily skills warm-up, district curriculum (lesson), and problem solving (task or lesson). The additional time spent in the mathematics classroom allows teachers to use problem solving and collaborative learning strategies necessary to improve deep understanding and develop skills.

Integration of Technology

In Math Forward, teachers use technology daily to enhance district lessons, provide students with immediate feedback about learning, and reinforce mathematics content through a wide variety of pedagogical mechanisms. Formative assessment is enabled through the use of graphing calculators integrated with a wireless classroom network. The teacher can send questions to the student devices, and students then send their answers back to the teacher for display and grading. The system allows the teacher to project classroom displays of their screens and student responses and also enhances student learning through a collaboration component.

Common, Aligned Assessments

Teachers are trained and required to administer assessments with students in the block classes at the beginning and end of each unit of study. Various forms of formative and summative assessments are used to inform teachers about students' content and procedural knowledge and the communication used to discuss content and processes within open response, or problem solving items.

The frequency of assessments allows teachers to meet individual student needs, and easily identify struggling students. Teachers are able to restructure lessons and activities prior to a student failing the course at the end of six-weeks, or waiting for the results of a district benchmark exam.

Accelerated and Rigorous Curriculum

Research has shown that the curriculum for underachieving math students often is narrowed to the low-level procedural, with little attention paid to the more demanding learning tasks involved in deep conceptual understanding and high-level problem solving. By contrast, the MathForward model is based on the principle that all students benefit from a rigorous curriculum: the right way to ensure math success for all is to build deep understanding and then expertise in problem solving.

Toward this end, MathForward coaches work with teachers to achieve appropriate rigor in the curriculum. Special supplemental learning activities and assessments aligned to state standards target key math concepts, principles and problem-solving strategies.

High Expectations for All Students

By middle school, many students lack self-confidence in mathematics. In this program, teachers create safe environments and encourage student responses. Students are valued for their ability to solve problems and are given tools to enhance content knowledge, justification, reasoning and proof. With the frequency of feedback and support students receive, they gain knowledge and confidence in their ability to do well in mathematics.

Increased Administrator and Parental Support

Administrator support is critical to success. Administrators participate in staff development, meet with project staff to discuss components of the model, and actively support implementation. Administrators set expectations for teachers and students during the initial phase of the project and continue to monitor progress throughout the year. Parental involvement and support of math learning is also critical to student success.

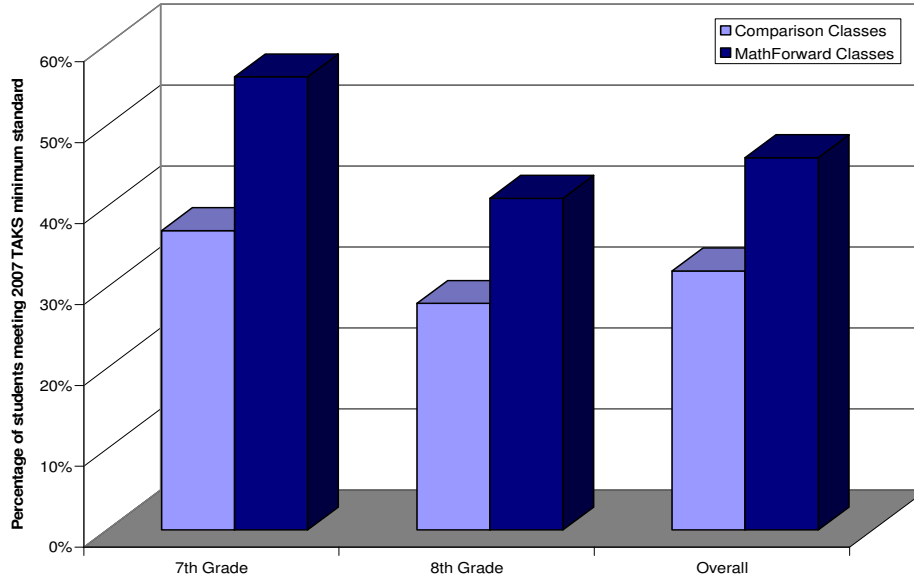
Results

In the 2005-2006 school year, the RISD pilot project involved 79 students who had failing test scores on the Texas state math test (TAKS). Most participants were African-American or Hispanic and most were from economically disadvantaged circumstances. The intervention resulted in 1/3 of students passing the test and increasing their scores by six points or more versus a comparison group with a pass rate of 19 percent and decline of one point.

RISD completed the second year of the program in 2007, with four more junior highs participating in the middle school program and two 9th grade Algebra pilots. The classes included struggling students, as well as those who were doing well in mathematics, including some Pre-AP students. 46% of the students who did not pass the state test last year successfully passed the 2007 TAKS and this represents an improvement when compared to last year's 33% pass rate, as well as a gain when compared to the comparison group. In addition, students in the program who were above the cut score improved their achievement when compared to the comparison group. 57% of MathForward, students participating in the 9th grade Algebra pilot who failed the state test in 2006, attained proficiency in 2007. By contrast, the comparison group had a 34%

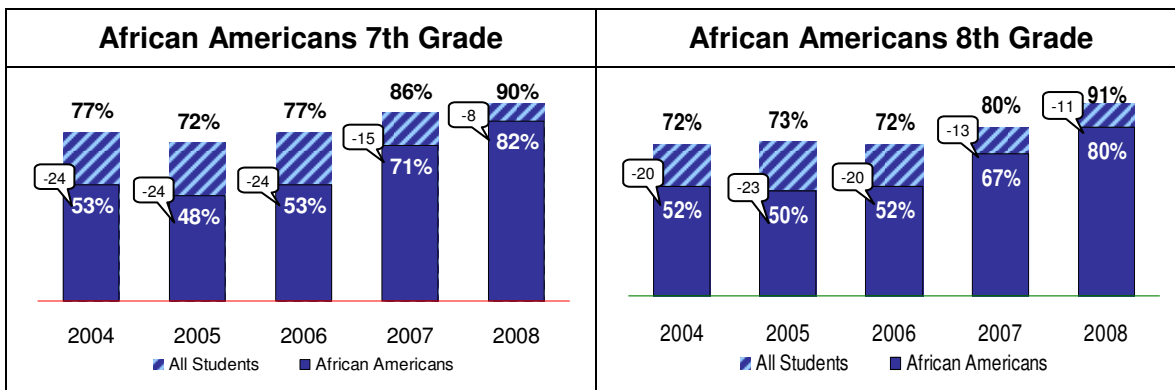
pass rate, suggesting that MathForward can be successfully extended from Pre-Algebra to Algebra.

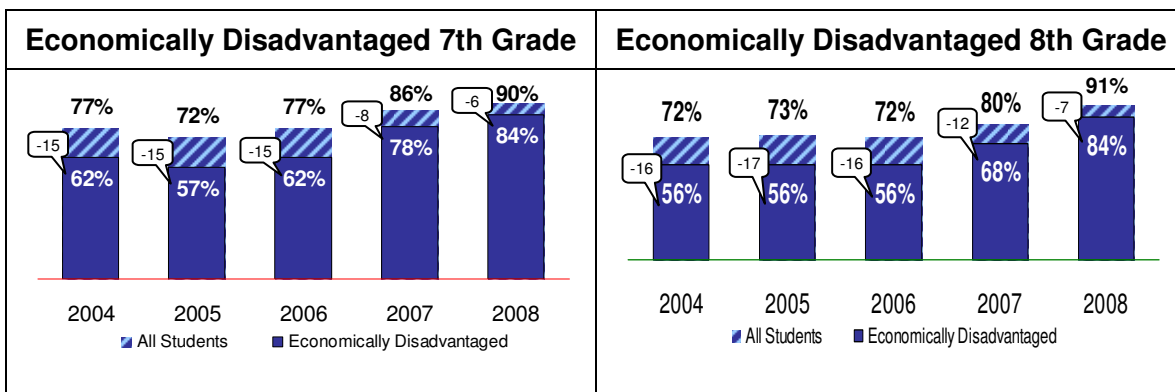
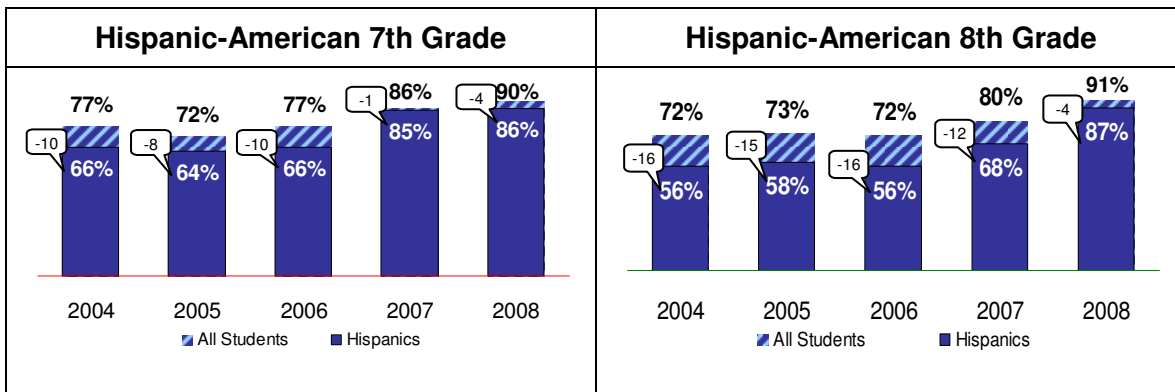
Percentage of RISD Students who failed to meet 2006 TAKS Minimum Standard who met 2007 TAKS Minimum Standard: MathForward versus Comparison Classes



As I mentioned earlier, in RISD, the program also has proven effective in closing the achievement gap for African American, Hispanic, and economically disadvantaged students. Detailed figures are illustrated below.

**Closing the Gap: Richardson Independent School District
Texas Assessment of Knowledge and Skills (TAKS)
Math Exam Pass Rate**





TI has rolled out additional sites, including districts in Dallas, Ohio, and Florida. In Ohio, the 2007 pass rate of students who were not proficient in 2006 and who were in MathForward was 45%, while the similar comparison group’s 2007 pass rate was 29%. In Florida, the program resulted in a 50% pass rate versus just under 40% for the control group. In Dallas, mixed results occurred due to structural problems with two incomplete implementations that are currently being reviewed. TI has also launched additional new pilots in Texas, California, and New York.

In expanding MathForward, TI is focused on scalability to additional schools, sustainability within the teaching staff, completeness of how the eight components of the intervention join synergistically to make a coherent and complete whole, and learning through continued research. MathForward is a model of how companies and districts can collaborate to improve student achievement in the critical pre-algebra and algebra concepts.

RECOMMENDED NEXT STEPS IN STEM EDUCATION

For our nation’s continued economic competitiveness, it is critical that business and government join together to address the challenges around STEM education. Our country has real national challenges that will need to be solved through science and engineering such as energy, medical, security and infrastructure.

In 2005, the Tapping America Potential (TAP) coalition of 16 business organizations led by Business Roundtable, joined together to advocate for renewed attention to U.S. competitiveness and America's capacity to innovate. TAP established an overarching goal to double the number of U.S. science, technology, engineering and mathematics (STEM) graduates with bachelor's degrees by 2015. TAP's recommendations for achieving that goal included improving STEM education, increased federal funding for basic research, and reforming U.S. visa policies to welcome the best and brightest. Among the K-12 STEM education recommendations were improved teaching capacity and a concentrated focus on middle school math.

Last week, TAP released an update report entitled *Gaining Momentum, Losing Ground* which found that while the issue of U.S. innovation has received increased attention in Congress and AmericaCOMPETES became law, generally increased appropriations for basic research and math and science education have not followed.

TAP supports full funding for several key federal STEM programs, including: MathNow, Math/Science Partnerships (MSPs) at the Department of Education and augmenting the MSPs at the National Science Foundation, AP/IB incentives, Noyce scholarships at NSF to encourage undergraduate STEM majors to enter teaching, and the NSF's Science, Technology, Engineering, and Math Talent Expansion Program (STEP). TI concurs with these recommendations as addressing essential STEM education needs.

MathNow was authorized in AmericaCOMPETES at \$95 million and requested in FY 2008 at \$125 million by the Administration, but received no funding through appropriations. The AP Incentive Program was authorized at \$74 million in AmericaCOMPETES, requested at \$122 million by the Administration in FY 2008, but received only \$44 million in final appropriations. AmericaCOMPETES authorized \$896 million for the NSF's Education and Human Resources Activities (including MSPs, Noyce, and STEP), but FY2008 appropriations provided \$726 million.

The Academic Competitiveness Council Report examining \$3.12 billion in federal STEM programs found that \$574 million, or 18.4% of the funds were directed at K-12 level and *only 1% (just over \$30 million) were programs specifically focused on K-12 Math*. Additional resources must be focused on the math literacy required for U.S. workers in today's global economy.

TI urges Congress to fulfill the promise of America COMPETES by providing key funding for STEM education, particularly targeted to algebra and algebra readiness. Algebra is the lynchpin not only for the STEM fields, but success in entering and completing college and in preparation for 21st century jobs at all levels.

TI also encourages Congress to reauthorize No Child Left Behind, while protecting the integrity of the original law – with high standards, assessments aligned to those standards, greater accountability and highly qualified teachers as the formula for continuing to drive improvement.

While sufficient funding of STEM programs is critical, there are other elements to consider. Programs in the K-12 STEM area should contribute positively to student achievement and the goals of NCLB. It is not enough just to stimulate student interest in science without developing the essential skills, specifically the foundations of algebra and beyond, needed to enter STEM fields.

In TI's experience, the most effective public/private STEM education partnerships meet the following criteria:

1. Program supports and/or builds upon state standards in mathematics and/or science. Efforts that do not support or enhance state standards can be a distraction to schools trying to comply with NCLB, particularly in low performing schools.
2. Professional development programs should tie into the NCLB requirement ensuring that teachers are highly qualified. Study after study demonstrates that teacher quality is a key determinant of student success.
3. Program is replicable and identifies the key elements for successful implementation.
4. Demonstrates some clear result, i.e., increased test scores, students taking tougher courses, etc. Soft metrics on the number of "students touched" or "teachers given professional development" are not sufficient.

By focusing resources on programs that meet these objectives, the private sector, federal, state and local governments can work together to ensure that all U.S. students develop the stronger math and science skills required to succeed in the global economy today and in the future.