The Academy of Medicine, Engineering and Science of Texas

THE NEXT FRONTIER

World-Class Math and Science Education for Texas

Education Committee Report on
Texas K–12 Math and Science Education

FINDINGS AND RECOMMENDATIONS

THE ACADEMY OF MEDICINE, ENGINEERING AND SCIENCE OF TEXAS

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REPORT BACKGROUND

"The economic and political events of the past months illustrate the vital need for the U.S. to unleash the talents of all of our citizens if we are to compete in the 21st century. We cannot afford to waste a single mind. Texas must do its part by educating every one of our young people, providing them with the knowledge and skills required to succeed in a technological world."

MICHAEL S. BROWN, M.D.
NOBEL LAUREATE
FOUNDING CO-CHAIR,
THE ACADEMY OF MEDICINE, ENGINEERING
AND SCIENCE OF TEXAS

In December 2006, The Academy of Medicine, Engineering and Science of Texas (TAMEST) created its Education Steering Committee to respond to the National Academies Report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*

The Committee's mission was to identify the challenges and opportunities in Texas' K–12 science, technology, engineering and mathematics (also known as STEM) education, and report back with practical, actionable recommendations.

Several recommendations can be implemented immediately, others within the next five years. But all are vital if we are to attain our goal of bringing math and science education to Texas students that is on par with the best in the world.

Improving Science and Math Education: Texas Confronts the Gathering Storm, an educational symposium, was held in October 2007. The Committee invited Texas and national leaders representing not only academia, but also government and private industry. This forum provided the opportunity to share data, pinpoint specific challenges and discuss solutions, and resulted in a concise list of recommendations, which the Committee built upon with in-depth feedback and input from over 150 STEM teachers, principals, administrators, policymakers and leaders across the state of Texas.

The challenges facing education in Texas are complex and urgent. Our state and national economic future, as well as the future of our children, hang in the balance. Therefore, the Committee's recommendations in this report are designed to address the most pressing needs and priorities. In the 21st century, new ways of teaching math and science skills to our children is truly the next frontier.

Will Texas Flunk Out of the 21st Century Economy?

"If we continue to ignore the obvious task at hand while others beat us at our own game, our children and grandchildren will pay the price."

NORMAN R. AUGUSTINE, CHAIRMAN, COMMITTEE ON PROSPERING IN THE GLOBAL ECONOMY OF THE 21ST CENTURY

Today's world is information-based, high-tech and global. In fact, according to the U.S. Bureau of Labor Statistics, of the 20 fastest-growing occupations projected through 2010, 15 will require substantial science or math preparation.[1] And over the next decade, the American demand for scientists and engineers is expected to grow four times faster than all other professions.[1]

Every day, the U.S. loses more and more jobs to the global workforce because our students have been inadequately prepared for careers that require strong math and science skills. Between 2000 and 2005, Texas lost more high-tech jobs than any state and ranked 29th in the number of scientists and engineers in its workforce.[2]

In China, 42 percent of college undergraduates earn degrees in science and engineering, compared with 5 percent of U.S. students.[3] Thirty years ago, one-third of the students attending college worldwide were Americans. Today, our college students account for only 14 percent of the total.[4] As the rest of the world is catching up, the U.S. and Texas are being left behind.

Quality K–12 math and science education is the only way the U.S. will reverse these trends and regain a competitive edge for the high-tech jobs of the future. But establishing an educated workforce has become increasingly problematic, especially in Texas. Texas has one of the lowest high school graduation rates in the country,[1] and almost

a quarter of Texans 25 and older don't have a diploma.[5] More often than not, students dropout when they become frustrated or discouraged by their low grades—often in science- and math-related classes. Every hour of every school year, 93 students dropout of Texas public schools—approximately 45,000 every year.[6] In fact, Texas spends more on dropouts each year after they leave school than it spent when they were in school.[7]

Not only does this cost the state an estimated $19 billion for one year's class of dropouts over their lifetimes,[7] but it also weakens the Texas economy as a whole. If the dropout disparity could be eliminated, some experts estimate the state would add a million new jobs and increase economic output by $1.9 trillion by 2030.[8] And a 25 percent increase in engineering degrees alone would add $6 billion to the Texas economy in 15 years.[9]

With an eye to the future, national leaders have begun to turn their attention to improving math and science education. In Texas, the Legislature has made great strides with programs such as 4x4 and the Texas High School Project's T-STEM Initiative, with a focus on aligning high school and post-secondary education with economic development activities to develop a skilled Texas workforce. Other programs, like the Texas Regional Collaboratives for Excellence in Science and Mathematics Teaching provide professional development to P–12 science and math teachers. It's a good start, but much more need to be done. And quickly.

Math and science education is still not viewed as a high enough priority in Texas and as a result, suffers from a lack of qualified teachers, innovative curricula and coordination with academic and professional realms beyond K-12.

TEXAS' HIGH SCHOOL GRADUATION RATE IS AMONG THE LOWEST NATIONWIDE.

IN CHINA, 42% OF COLLEGE UNDERGRADUATES EARN SCIENCE OR ENGINEERING DEGREES; IN THE U.S, ONLY 5% OF STUDENTS DO SO.

FINDING 1

Simple Arithmetic: Teacher Training + Support + Pay = Recruitment + Retention

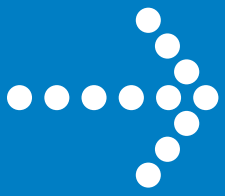
In 2007, approximately 4,000 Texas math and science teachers left the classroom. IT COST THE STATE AN ESTIMATED $27 MILLION *to replace them.*

Every successful person remembers that one special teacher. Teachers make the single biggest difference in academic achievement, regardless of students' economic, social or ethnic backgrounds.[12,13] A shortage of qualified math and science teachers directly and negatively affects students' performance.[10] And with rigorous new state standards, the teaching pool will be stretched even further.

New initiatives, like Texas' Four by Four (4x4), requiring students to complete four math and four science courses to graduate, are increasing the demands on teachers as well as students.[10] Educational and industry leaders acknowledge these initiatives are an essential step in preparing students for college and the global workplace. But building an educated workforce takes educated, passionate teachers—fully certified in their subject matter and dedicated to a career in teaching. The changing world also applies to teachers. Teachers must remain current in their subject area and be exposed to and trained in the use of the technology and tools of the discipline to effectively utilize them in their classrooms. Continued, high quality, professional development is critical, both for teacher retention and for strengthening the quality of teaching and learning in our schools.

Committed to their profession, teachers face the challenge of continuing their own education in their subject area, as well as in new and evolving technology, so they can use and teach it in their classroom. Ongoing professional development is a must, for strengthening both our teacher talent pool and the quality of education in our public schools.

RECOMMENDATION 1



The Three R's—
Recruiting, Rewarding & Retaining

ACTION STEPS 1–A:

Train Our STEM Teachers

- Expand, fund and track the effectiveness of STEM teacher training programs in as many Texas colleges and universities as possible, and replicate effective training programs with private sector and industry partners
- Identify, fund and develop successful continuing professional education programs for STEM teachers throughout the state

Texas needs teachers who can engage students while teaching effective math and science curricula. This calls for high-quality, specialized training on multiple levels, including long-term, pre-service and in-service programs. Texas must also ensure that Alternative Certification Programs (ACP) are more consistent in preparing teachers for math and science education. Studies show that teacher qualification levels are lowest in schools on the lower end of the socioeconomic scale—which unfortunately results in the highest-need schools having the least-qualified teachers.[10]

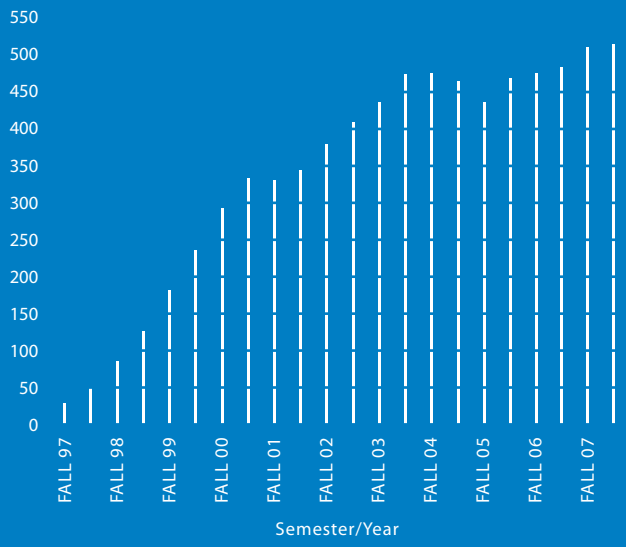
UTeach, a program developed at The University of Texas at Austin, specializes in teacher training for math and science majors, new teacher support and ongoing, advanced science and math education certification. MASS, a Texas A&M University program, also focuses on recruitment and teacher preparation of STEM majors. The state needs to replicate and fund more programs like these on a statewide basis.

IDEAS THAT GET AN A+

UTeach

UTeach, a teacher training and support program launched at The University of Texas at Austin in 1997, provides full teaching certification for undergraduates majoring in math, science and computer science, without adding time or cost to their degree plan. A unique collaboration between the Colleges of Natural Sciences and Education, UTeach employs master teachers from around the state to provide real-life experience, guidance and inspiration for up-and-coming science and math teachers—both while they're in and once they're out of college. UTeach master teachers lead courses and coordinate field-based training while students are earning their degrees, then offer on-the-job support once novices are working as teachers themselves. The program is making a quantifiable difference: UTeach graduates have higher GPAs and a higher graduation rate than other Natural Sciences graduates, almost half teach in high-need schools, and 80 percent—compared with only 50 percent nationally—are still teaching after five years.

UTeach Enrollment



ACTION STEPS 1–B:

Support New STEM Teachers

- Create a comprehensive two-year support system for all new math and science teachers, using an induction method that includes coaching, mentoring, weekend workshops and online support
- Offer additional training and mini-courses for math and science professionals entering the teaching workforce without formal teacher preparation

Finding qualified teachers is difficult, but keeping them can be even harder. Only 58 percent of Texas' secondary school students are taught by teachers who majored in their subject field—well below the national average of 81 percent.[16] And in 2005, only 5 percent of teachers seeking alternative math and science certification had been scientists, mathematicians, engineers or computer scientists prior to their careers in education.[17]

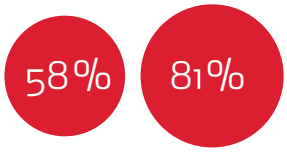
Nationally, half of new teachers leave the profession within the first five years.[18] In 2005, almost 38,000 Texan teachers left the classroom.[19] Some retired, but many switched to other professions, saying they were discouraged by the teaching environment.[10, 18, 19] As Texas' school-age population grows, the demand for new teachers increases by an additional 5,000 new teachers each year.[19] Texas is having difficulty keeping up. In the state's poorest schools, almost half of math teachers and a third of science teachers have three years of experience or less.[10]

Support and training programs, especially for new teachers, can reduce turnover, increase job satisfaction and improve their performance and effectiveness. What's more, these programs save Texas money. Training and supporting teachers costs less than replacing them.

UTeach, of The University of Texas at Austin, is a superb model. UTeach encourages math and science majors to enter the teaching profession by offering a STEM degree plan integrated with teacher certification, financial assistance and early teaching experience for undergraduates. And then, to support those new teachers, it offers a two-year induction program and a three-year summer Master's program. UTeach has demonstrated remarkable results—after five years, 80 percent of its graduates are still teaching, 20 percent higher than the national average.[20]

New teachers are recruited from STEM degree students into Texas A&M University's MASS program, run through A&M's College of Science. Working with mentors in a field-based, hands-on environment, these math and science majors achieve teacher certification without adding hours to their degree plan. This program, in concert with math and science middle school certification, post-baccalaureate and online alternative certification, leads the state in terms of output of certified mathematics and science teachers.[21]

New teachers benefit enormously from further training, mentoring, teachers' aides and a support network of professionals during their first year. Teacher turnover rates drop while confidence and job satisfaction rise. It is far more economical to support good STEM teachers than to recruit and train new ones.



Only 58% of Texas' secondary school students are taught by teachers who majored in their subject field—well below the national average of 81%.

In 2005–06, the National Education Association RANKED TEXAS' AVERAGE TEACHER SALARY AT 35TH NATIONWIDE.

ACTION STEPS 1–C:

Improve Pay and Financial Incentives for STEM Teachers

- Improve math and science teacher compensation by building on current state incentive programs
- Offer increased stipends for fully certified teachers with a degree in a STEM field
- Offer higher compensation for fully certified math and science teachers in high-need schools
- Offer performance-based salary supplements
- Increase salaries for STEM-area specialists—mentors, master teachers, curriculum advisors—including those serving primary grades
- Offer financial aid for math and science teachers pursuing advanced degrees and continuing education opportunities (e.g., Master Teacher programs), in exchange for a three-year commitment to teach those subjects in Texas K–12
- Offer financial incentives to teachers who acquire advanced degrees in STEM fields

While all Texas teachers deserve to be compensated fairly, Texas' math and science teachers' salaries continue to lag behind compensation for comparable STEM professionals, and the gap is widening.[10, 23] According to the National Education Association, the average Texas teacher's salary in 2007 ranked 35th nationwide.[24] In 2007, the average salary for secondary mathematics and science teachers was almost $47,000 as compared to almost $71,000 for those in computer/mathematical occupations or architecture, and $87,000 in engineering occupations.[10] In addition, math and science teachers' salaries quickly stagnate, forcing them to give up teaching and seek higher-paying positions in administration or private sector jobs. It doesn't take a math genius to see the potential problem.

Texas finds itself competing with private industry for the best and brightest minds. Teachers with strong math and science backgrounds are being lured to higher-paid professions with performance-based bonuses, financial incentives to continue their education, lighter workloads and better working conditions. Is it any wonder teacher turnover is so high?

A professionally satisfied teacher is a good teacher. Texas must implement strategies to help recruit and retain qualified math and science teachers.

IDEAS THAT GET AN A+

Santa Cruz New Teacher Project

The University of California, Santa Cruz New Teacher Project (SCNTP) was created in 1988 as a collaboration between the university's Teacher Education Program, the Santa Cruz County Office of Education and 16 school districts, committed to supporting and assessing new teachers in order to promote the highest level of classroom instruction. The initiative provides intensive, individual support to new teachers during their first two years, including pairing with veteran teacher advisors, a monthly seminar series and 'release time' opportunities. Support is guided by a continuing cycle of assessment centered around the development of each teacher's district goals and learning plan. Studies show the program is working; after eleven years, over 95% of SCNTP teachers are still in the classroom.[22]

Reasoning Mind

Effective technology-based programs have high scalability and, therefore, high potential for success. The Reasoning Mind mathematics education system is a prime example of such a program. Reasoning Mind uses the Internet to deliver a math curriculum to grades 2–6 that delegates routine instructional tasks to the computer and frees the teacher to address students' individual needs. Studies show that Reasoning Mind students perform 10–20 percent better than their peers on TAKS and other math achievement tests, and 76 percent of students say they like math more than before they participated in the program.[37] Due to its student-centric approach, the program benefits a broad spectrum of students, from special-need to gifted and talented.

Teach For America (TFA)

Teach for America is a national corps of the best and brightest recent college graduates—of all majors and interests—who commit to teach in urban and rural schools for two years. TFA invests in their training and professional development in order to accomplish their mission of eliminating educational inequity. For students at the primary school level, the negative impact of successive years of low-performing teachers can be irreversible.[12, 13]

Studies of the best-performing school systems in the world suggest the quality of the teachers is the key factor in disparate student learning levels, no matter what the cultural environment.[14] According to these studies, two of the most significant practices in achieving high-performing school systems are finding the right people to become teachers and developing them into effective instructors. A selective recruiting process and specialized training produces excellent teachers, which leads to higher-performing schools. This level of quality adds prestige to the teaching position, which in turn attracts more talented people to the field.[14] In 2008, 25,000 individuals applied for positions at Teach For America and only 3,700 were recruited into the program.[15]
TFA is a model of the best practices employed in the best school systems in the world.

ACTION STEPS:

No STEM Teachers Left Behind

- Fund para-professional teaching assistants, trained to support science and math teachers with classroom instruction, lab prep and grading assistance, and science specialists at the elementary school level
- Reduce the teaching load by one class for first-year math and science teachers to allow for induction support and facilitate course development
- Familiarize school leadership with the unique challenges of math and science teaching (e.g., New Leaders for New Schools, a training program for aspiring principals in struggling urban schools)
- Incentivize higher education faculty, postdoctoral fellows and industry experts to teach or serve as STEM advisors

  – *The National Science Foundation's Graduate Teaching Fellows in K–12 Education,* or *GK–12 Program*—helping STEM grad students to become secondary math and science teachers through fellowships and ongoing training
  – *The National Science Foundation's Robert Noyce Teacher Scholarship Program*—scholarships, stipends and other financial support for STEM students and professionals committing to teach in high-need K–12 schools
  – *Baylor College of Medicine/Texas A&M University's Opening Pathways for Teacher Instructional Opportunities in the Natural Sciences (OPTIONS)*—online alternative certification for STEM students and professionals transitioning to secondary education careers

FINDING 2

An Object In Motion Tends to Stay In Motion

Texas must do more to interest students in math and science fields, and to keep those students on the path of pursuing STEM degrees and careers.

CLOSE TO 40% OF STUDENTS AT TWO-YEAR COLLEGES AND 25% AT FOUR-YEAR UNIVERSITIES ENROLLED IN A REMEDIAL COURSE, *costing Texas $300 million per year.*

Elementary-age students are almost always fascinated with science. Field trips, science fairs and hands-on experiments bring scientific concepts to life in exciting and tangible ways.[25] But by high school, too often, the thrill is gone.

It doesn't need to be this way. Well-designed curricula and effective teachers can inspire students to pursue their degrees in math and science. And Texas' new and tougher College Readiness Standards and 4x4 requirements will help ensure students are prepared for college-level math and science. Efforts like these can have a dramatic, lifelong effect on our children's futures. During their lifetime, college graduates with a degree in math or science earn up to $1.2 million more in total salary than those without a college degree.[26]

The Texas Higher Education Coordinating Board and the Texas Education Agency have demonstrated their commitment to higher academic achievement. Overall, tougher state standards will improve alignment between public and higher education curriculum. But on an individual basis, instructional strategies can and do vary from district to district, and even classroom to classroom.

It's the teachers who balance standardized test concepts with creativity, reasoning skills and problem solving techniques that'll bring their students to the next level.

Texas must ensure its teachers have the right tools at their disposal to inspire their students and encourage math and science studies. As noted in the Committee Finding and Recommendation I, professionally trained and motivated teachers are the schools' front line for delivering meaningful and effective lessons.

RECOMMENDATION 2

Encouraging Students To Think Creatively Requires Creative Thinking

To capture their imagination and engage students in math and science, Texas needs to think outside the box—exploring and supporting a wide range of programs, resources and innovative methodologies.[25] Studies show that teaching students in environments other than the classroom brings a deeper level of interest and understanding of concepts.[25] Information presented in the form of experience is more easily assimilated and remembered. But field trips require more financial resources. The state must ensure that funding is available so that students have the opportunity to learn through interactive experiences that perpetuate interest in STEM subjects, and the appropriately equipped science labs to apply what they learn back in the classroom.

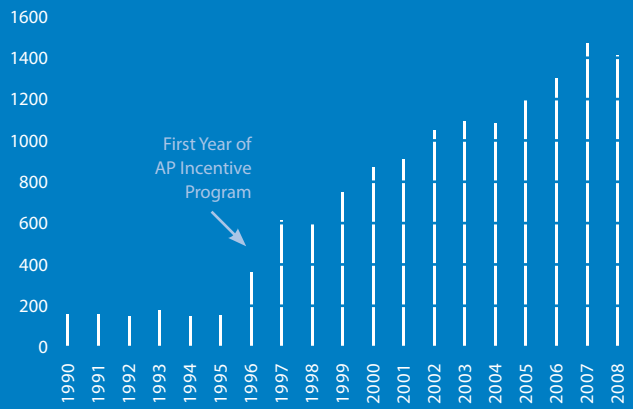
IDEAS THAT GET AN A+

Advanced Placement (AP) Strategies

AP Strategies is a leader in preparing high school students for higher education. AP students learn college material from high school teachers. Passing AP classes and scoring a 3 or higher on AP exams allows students to gain college-level skills and in some cases, college credits. The AP Incentive Program was launched in Texas schools to promote strong performance on the AP exams by providing a monetary stipend for both teachers and students at the successful completion of the exam. The program has dramatically improved performance: in ten high schools in the Dallas Independent School District, the number of students passing math, science and English AP exams went from 157 in 1995—the program's first year—to 1,466 in 2007, a nine-fold increase.[36] And in those same subjects, passing scores by African-American and Hispanic students jumped twenty-two-fold—from 29 in 1995 to 664 in 2007.[36]

There is a direct link between AP success and college graduation. A 2005 study conducted for the National Center for Educational Accountability found that 64% of students who earned a score of 3 or higher on one or more AP exams in math, science, English and social studies graduated from college in five years or less, compared to only 17% of non-AP students.[36]

AP Passing Scores in Math, Science and English at TIF Dallas ISD Incentive Schools



ACTION STEPS 2–A:

Support a Variety of Ways to Keep Students Engaged In STEM Curricula

- *Advanced Placement/International Baccalaureate Incentive Programs*—continue and increase state support of the Texas AP/IB Incentives Programs for recognizing and rewarding students, teachers and schools that succeed in achieving Texas' educational goals
- *Advanced Placement Strategies*—use public and private funds to expand the presence of AP Strategies, a program encouraging success in AP math, science and English courses, through financial rewards, as well as the pre-AP teacher training program, Laying the Foundation, in as many Texas school districts as possible
- Advanced technologies—make sure the latest technology is being leveraged to optimize STEM education
- Science labs—fund and equip school science labs
- 4x4 curriculum options—computer science, engineering, anatomy and physiology, robotics and earth science should be offered as options to fulfill fourth-year science requirements; statistics should be offered to fulfill fourth-year math
- English language skills—English mastery is essential to STEM success

Once students are engaged in math and science curricula, how do we keep them engaged? Approach the problem from all angles. There are lots of resources, innovative programs and curricula designed specifically to stimulate and support STEM education and students. Unfortunately, many are either currently unavailable or underutilized in Texas classrooms at the moment.

The Charles A. Dana Center at The University of Texas at Austin has spearheaded the development of standards and professional development for an exciting new

fourth-year mathematics course called Advanced Mathematical Decision Making. In this course, students will learn to become critical consumers of the quantitative data that surround them every day through the use of statistics and mathematics modeling applied to current topics such as voting, finance and risk assessment.

Programs like AP Strategies are an excellent example of the public and private sector partnerships between Texas schools, businesses and the philanthropic community. AP Strategies manages programs for private donors to provide financial incentives to teachers, students and schools based on academic success in AP math, science and English, with the goal of preparing high school graduates to enter college and earn a degree. In the 2007–08 school year, only 76 of the state's more than 1700 high schools participated in the AP Incentive Program.[27] It should be at work in as many school districts as possible statewide. For students with similar high school rank or SAT scores, those with AP credit significantly outperformed their peers with no AP credit. Performance of AP students was higher, regardless of gender or ethnicity.[28] The six year graduation rate from Texas public colleges and universities for Hispanic students who passed an AP exam was 62 percent, versus only 15 percent for those who did not take an AP exam.[35]

Without partnerships with industry and higher education leadership, Texas would have tremendous difficulty keeping up with useful advances in technology, like Web-based tools developed and optimized for use in K–12 environments.

Among the curricular deficiencies that need to be addressed in order to improve STEM education are English language skills. English is the international language of science and, therefore, a prerequisite to success in STEM areas. Yet, Texas English as a Second Language (ESL) students have achievement gaps as high as 33 percent for math and 40 percent for science.[29, 30, 31] When students lack strong English comprehension and communication skills, they can't master other subjects and become discouraged by their inability to keep up—one of the top reasons Texas students drop out of school.

Texas needs to address Hispanic students' needs in powerful ways, starting with bilingual programs. In 2007, 34 percent of Hispanic students—731,000 students—were enrolled in bilingual programs, with 62 percent of the students in pre-K to third grade.[32] The Texas Assessment of Knowledge and Skills (TAKS) pass rate of bilingual students in every grade is lower than the pass rate for all students and dramatically lower in grades 8–11.[32]

Bilingual classes are clearly not working, yet their cost to Texas in 2007 was $1.1 billion dollars.[33] Better approaches and incentives for success, such as summer immersion courses and outstanding teachers, would cost the state far less. Hispanic students are a tremendous source of untapped talent. Ninety-three percent of Hispanic voters believe education is extremely important or is a very important issue for their families,[34] and across the state, there are pockets of Hispanic students at the top of their classes. In Dallas alone, those students pass AP exams in math, science and English in numbers three times greater than their counterparts in other areas of the U.S.[35] They can do the work. Texas must do everything it can to give them the chance to succeed.

IDEAS THAT GET AN A+

The Infinity Project

Created in 1999 in a partnership between the Institute for Engineering Education at Southern Methodist University and Texas Instruments, the Infinity Project is an award-winning program that's trained over 360 educators and worked with more than 230 schools. The program's goal is to stimulate interest in math and science using a dynamic approach, state-of-the-art curriculum and a classroom technology kit, combined with professional development and support for the teachers. With examples and technologies relevant to students—such as MP3 players and special effects—the Infinity Project helps students understand math and science in real-life terms. The results? Sixty-five percent of Infinity graduates plan to pursue engineering degrees.[38]

FIRST

For Inspiration and Recognition of Science and Technology (FIRST) was created in 1989 to inspire young people's interest and participation in science and technology. One of the organization's best-known initiatives, the FIRST Robotics Competition, is a unique sport of the mind designed to help high school students discover how fascinating and rewarding research and engineering can be. The event challenges teams and their mentors to solve a common problem within six weeks, using a standard kit and common rules. Teams build robots and enter them in competitions. Rewards are given for excellence in design, team spirit, professionalism and overcoming obstacles. National Instruments, headquartered in Austin, is one of the largest global supporters of FIRST, and has been instrumental in bringing these hands-on and proven programs to Texas K–12 students.

Project Lead the Way (PLTW)

Project Lead the Way (PLTW) is a national nonprofit organization with partners in public schools, higher education and the private sector. PLTW aims to introduce students to the fields of engineering, biomedical sciences and technology using a combination of college prep math and science programs and a specially designed four-year series of courses based on an approach known as APPB-learning: activities-based learning, project-based learning and problem-solving learning. With hands-on, real-world projects, math and science become relevant to students, helping them to develop critical thinking and cooperative learning skills. The program began in New York State in 1997 with four high schools participating. The following year, a middle school program, Gateway to Technology, was field tested in three middle schools. Today, the programs are offered in over 3,000 schools across the U.S. Studies show that students who participated in APPB-learning are better prepared to enter specialized college degree programs than those only exposed to traditional curricula.[39]

ACTION STEPS 2–B:

Fund Programs That Make Math and Science Real for Kids

- Hands-on experiments, activities and field trips
- Internships
- Mentoring relationships like Science Olympics, FIRST, UIL and the Texas Junior Academy of Science
- Support and expand the roles of museums, science centers and similar institutions that provide students with various community-based exposure to math and science-related exhibits and activities
- Support existing programs that offer interested high school students hands-on experience in college and university research labs

Encouraging new and existing programs that go beyond classroom instruction generates student excitement and brings math and science to life. Hands-on, project-based programs have the power to change young minds. Students usually begin with the belief that they don't like or care about math or science. But once engaged, they are often on their way to becoming college material.

Among Texas teens, only 20% tested have passing mastery (a score of 70% or better) of science, and only 50% have passing mastery of math.

ACTION STEPS 2–C:

Help Strong Students Follow Through with Successful Math and Science Studies

- Provide financial assistance for economically disadvantaged students interested in math and science to attend Texas colleges and universities

Graduating from high school with career- or college-ready math and science skills is an increasingly essential step toward a financially secure future for today's youth. A quality education can help break the cycle of poverty. Yet among Texas schools with more than 85 percent of students qualifying for free or reduced-price lunches, none have more than 10 percent of their entire student populations that would qualify as college-ready under state criteria.[40] It is imperative for Texas students to understand why math and science matters—not just in their everyday lives, but also to their future earning power. As noted previously, students who graduate college with a degree in math or science will earn up to $1.2 million dollars more during their lifetimes than those without a degree.[26]

When students display interest and ability in math and science subjects, they must be encouraged to go further and pursue their degrees and careers in those subjects at Texas colleges and universities—regardless of their socioeconomic status or ability to pay their own way.

Public-private partnerships like the Texas High School Project's T-STEM Initiative can help increase the number of students who continue their studies and go on to professions in math and science. The program has created 35 T-STEM Academies, 7 T-STEM Centers and a T-STEM Network with the goal of producing high school graduates each year who are college-ready for math and science degree programs. Helping talented Texas students earn these degrees is an investment that pays dividends—to the student and the state—for many years to come.

IDEAS THAT GET AN A+

Laying the Foundation

A Texas-based, nonprofit organization, Laying the Foundation is a high-quality training program for pre-AP math and science teachers. Using Web-based resources and rigorous classroom materials, Laying the Foundation prepares students for success in Advanced Placement and other college-level courses by emphasizing lab work and problems with real-world applications. Middle school math classes work through problems like "Emission Possible," calculating the carbon dioxide footprint of their class relative to global warming. Science class projects like "Crumple Zone" explore Newton's law of motion by using a paper bumper to stop a car before it reaches the "crumple zone." Laying the Foundation's teaching materials were created by Texas teachers in 2002 and have been so successful that this year, it began expanding nationally.

Joint Admission Medical Program (JAMP)

The 77th Texas Legislature created JAMP to encourage and support highly qualified, economically disadvantaged students who wish to pursue a medical education. Eligible students can receive undergraduate and medical school scholarships, as well as guaranteed admission to a Texas medical school. Students must be Texas residents, show sufficient financial need and maintain a minimum 3.25 GPA. Operating successfully since 2003, JAMP has selected dedicated students from 65 colleges from all across the state, contributing to a diverse student body at Texas' eight medical institutions that more closely reflects the state's population. Scaled and applied to Texas high school commended students, this program could serve as a strong incentive for our state's best students to enter STEM disciplines at Texas universities.

Career and Technical Education (CTE)

The CTE program exists to support the goals of the State Plan for Career and Technical Education—specifically, to allow students in the program to master the basic skills and knowledge necessary to enter the workforce in a high-skill, high-wage job or to continue their education in a post-secondary institution, while at the same time managing the dual roles of a family member and wage earner. Rigorous CTE courses reinforce relevance and offer more opportunities for hands-on and student-centered learning.

FINDING 3

This Concludes the Multiple Choice Section of Our Test

Only 41% of Texas high school graduates are ready for college-level math (algebra), AND ONLY 24% ARE READY FOR COLLEGE-LEVEL SCIENCE (BIOLOGY).[41]

For today's Texas students, K–16 STEM education can no longer be optional. A solid foundation in math and science skills will be a major factor in determining their future success or failure in the new global economy.

On the 2007 Nation's Report Card in science, 48 percent of America's fourth-graders and 64 percent of America's eighth-graders scored higher than Texas students.[43] In 2006, high school students passed their math exit exams scoring less than 70 percent on half of the tested objectives, and their science exit exams by scoring less than 70 percent on 80 percent of the tested objectives.[30] All efforts to improve Texas K–12 STEM education will be irrelevant if students graduate from high school inadequately prepared for college courses.

Today, roughly 40 percent of students at two-year Texas colleges and 25 percent of students at four-year Texas universities are enrolled in at least one remedial course[43] —costing the state close to $300 million a year in remedial education.[44] Even more alarming, almost 80 percent of these remedial students had a high school GPA of at least 3.0.[43] They thought they were ready for college.

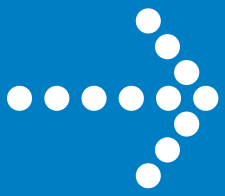
In the knowledge-based economy of the 21st century, college readiness is workforce readiness—and the fact is, Texas' K–12 public education system is not aligned with preparing students for today's work place. This is, indeed, our next frontier.

Beginning in elementary school, educators must focus on analytical, critical-thinking and problem-solving skills, as well as technology. High schools must raise academic expectations and improve academic results. Texas must work to create a more interconnected K–16 system with common goals and standards, ensuring rigorous math and science courses, exams and graduation requirements. It won't be easy, but there's no other choice.

Refining accountability is one key to improving Texas K–12 education. Ideally, an accountability system accurately accesses the quality of the state's public school system, rewards what's succeeding and determines the most effective ways to remedy what's not.

Unfortunately, Texas' current accountability system is frustratingly complex, with numerous academic measures to rank schools and districts that do not align to state educational goals—a poor use of time for busy school officials. The system also places too much focus on minimum performance at the expense of annual growth toward commended performance. Increased transparency through better technology would help create a more effective accountability system for Texas K–12 public schools.

RECOMMENDATION 3



Extra Credit Will Be Given For Showing Your Work

Texas must articulate and align math and science concepts and skills to higher education and industry needs. And it must do a better job of rewarding students and schools that meet those definitions.

ACTION STEPS 3–A:

Ensure Effective Alignment and Teaching of STEM Concepts

- Work more closely with Texas higher education institutions, industry and K–12 educators to identify and define specific concepts and skills students need to succeed in math and science degree programs
- Develop high school classes specifically aligned to these concepts and approved by the Texas Education Agency as either 4x4 or dual/concurrent enrollment courses
- Increase technology funding to ensure districts get the necessary equipment for these courses, contingent on teachers becoming and staying current
- Support the continued implementation of the Texas Higher Education Coordinating Board's College Readiness Standards

Currently, high school exit exams are not aligned with college entrance standards. Fifty-nine percent of Texas students requiring remedial coursework in colleges and universities say their high school classes were too easy, and almost half would have preferred harder classes that would have better prepared them for college.[43]

Texas must work with higher education institutions, private industry and K–12 educators to develop and fund a vertically aligned curriculum that ensures students with strong math and science skills will successfully make the transition from high school to a college degree program.

ACTION STEPS 3–B:

Emphasize and Reward High Performance and Improvement

- Modify current accountability measures to emphasize commended students, growth and progress
- Recognize and reward schools whose students advance to magnet schools

Testing is an integral part of evaluating effective math and science learning, but Texas' accountability system doesn't place enough value on students earning commended status—the state's most accurate measure of college-readiness.

ACTION STEPS 3–C:

Incorporate More Transparency Into K-12 Information Systems

- Allow teachers better and quicker access to K–12 educational performance data
- Fund development of Web-based tools that enable leadership to motivate and reward improvement in math and science education
- Begin annual science testing for students in grades 3–8, in addition to high school end-of-course exams
- Perform district-wide external curriculum audits in math and science every six years

Increased transparency creates a higher level of accountability and better-performing schools. Studies of the world's top-performing school systems reveal that those seeking transparency in their performance create greater public awareness and accountability, which in turn spurs further improvement.[14] With transparent performance information, teachers can access and share data, allowing them to improve how and what they teach.

In addition to greater transparency, top-performing schools also regularly utilize school reviews and student testing to monitor their progress.[14] Unfortunately, while Texas students are being tested annually in math, the same is not true for science, making it difficult to effectively track student progress. According to science teachers statewide, science curriculum is often neglected during non-testing years, putting students at risk of lagging behind their peers elsewhere. But even annual testing is not enough; it must be coupled with diagnostics during the school year to give teachers prompt and accurate performance feedback, ensuring timely and meaningful response to instruction.

IN TEXAS' POOREST SCHOOLS,

ALMOST HALF OF MATH TEACHERS ARE CONSIDERED NOVICES

(FEWER THAN THREE YEARS' EXPERIENCE)

AND MORE THAN ONE-THIRD OF SCIENCE TEACHERS ARE NOVICES.

FINDING 4

Statewide K-12 STEM Education—Elective or Prerequisite?

"Now is the time to take the next step by aligning our curricula, standards and assessment with that goal to ensure students are gaining the knowledge they need to be career- or college-ready upon graduation."

BILL HAMMOND, PRESIDENT AND CEO TEXAS ASSOCIATION OF BUSINESS

Texas must make math and science education an even higher priority.

Texas students consistently score below the national average on science AP exams[45] and in 2006, Texas ranked 43rd nationwide in expenditures per K–12 pupil[1]. From how much the state invests in our youngest students to how well even our smartest students score on tests, K–12 public education—and math and science education in particular—must become a top priority in Texas.

The legislature has made significant progress at the front end by establishing the new College Readiness Standards and 4x4 graduation and end-of-course testing requirements. But system-wide infrastructure and implementation guidance will be necessary to ensure successful follow-through and give Texas students a 21st-century math and science education.

RECOMMENDATION 4

Going Beyond the Student Council

Establish STEM education as a top priority by creating a Texas advisory panel of high-powered STEM professionals charged with improving the system.

There's no argument among Texas leaders that math and science education is vital to the economic future of our students and our state. It is time to demonstrate our commitment to K–12 STEM education by officially dedicating high-level people and resources to measurably improve our system, and bring it on par with the best the world has to offer in math and science education.

ACTION STEP 4–A:

Create a Texas STEM Advisory Council

- Use the National STEM Education Council as a model and create a statewide advisory panel made up of classroom teachers, school leaders, higher education representatives, industry leaders and policymakers

The Texas STEM Advisory Council would be responsible for:

- Identifying the math and science concepts relevant to current and future workforce needs, as well as the resulting gap in today's public education system to meet those specific needs
- Analyzing and summarizing scientific evidence related to math and science education, specifically focusing on student preparation and success
- Advising policymakers and education agencies on STEM-related decisions
- Identifying and promoting instructional practices, programs, materials and professional development that have been proven effective in enhancing math and science education (i.e., a council "seal of approval")
- Identifying and advancing programs that promote student and parent understanding of the benefits of STEM education—including the value of math and science fields to society, as well as lucrative career options for students
- Coordinating statewide efforts to support or expand existing effectual math and science courses that help fulfill 4x4 graduation requirements
- Determining STEM research and data needs and developing an information-management system—including Web-based tools—to drive improvement

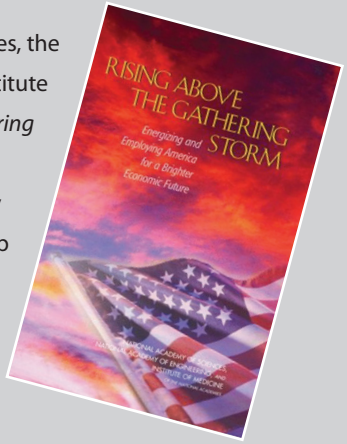
ABOUT TAMEST

THE ACADEMY OF MEDICINE, ENGINEERING AND SCIENCE OF TEXAS

The Academy of Medicine, Engineering and Science of Texas (TAMEST) was founded in 2004 by U.S. Senator Kay Bailey Hutchison and Nobel Laureates Dr. Michael S. Brown and the late Dr. Richard E. Smalley. TAMEST is comprised of Texas Nobel Laureates and 250+ members of the National Academies, working to strengthen our state's position as a national research leader and hub of achievement within these fields, and to help cultivate the next generation of Texas scientists.

TAMEST unites our state's top scientific, academic and corporate minds, facilitating connection among professionals who have been elected to the National Academy of Sciences, the National Academy of Engineering or the Institute of Medicine. Together, they promote and honor excellence in their respective fields, help determine our state's research priorities for the future, and offer an extraordinary intellectual resource for public and private entities throughout Texas.

ABOUT THE NATIONAL ACADEMIES REPORT



In November 2005, the National Academies—comprised of the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine—released *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. The report, originally requested by a bipartisan Congressional group concerned about maintaining U.S. leadership in science and engineering, warns that our nation faces serious challenges from global competition.

Rising Above the Gathering Storm outlines actions the federal government should undertake to ensure America's economic leadership and competitive capability, including:

- Expanding our nation's talent pool by vastly improving K–12 science and mathematics education;
- Ensuring the U.S. is the premier worldwide destination to study and perform research so that we can develop, recruit and retain the best and brightest students, scientists and engineers; and
- Ensuring the U.S. is the premier worldwide destination to innovate—investing in manufacturing and marketing, modernizing the patent system in order to create high-paying innovation-based jobs, realigning tax policies to encourage innovation and ensuring affordable broadband access.

ABOUT THE PROJECT SPONSORS

The Academy of Medicine, Engineering and Science of Texas is grateful to the following organizations for their generous support of this project:

The Dow Chemical Company Foundation

The Dow Chemical Company and its Foundation support educational initiatives around the world. Through partnerships with leading educational organizations and the involvement of its employees as volunteers, Dow is committed to improving students' understanding of math, science and technology.

Houston Endowment

Houston Endowment is a private philanthropic foundation that improves life for the people of the greater Houston area through its contributions to charitable organizations and educational institutions.

O'Donnell Foundation

The O'Donnell Foundation's goal is improving education. It focuses on four areas: math, science and engineering, especially at the graduate level; medicine; improving the K–12 teacher corps; and arts education. It piloted the Advanced Placement Incentive Program in Texas, as well as the Laying the Foundation training program for pre-AP teachers in grades 6–11. Both programs were cited as models for replication in the *Rising Above the Gathering Storm* report and both are now being replicated in six other states.

The Greater Texas Foundation

The Greater Texas Foundation supports excellence in education in the state of Texas through initiatives that: enhance math and science education at all levels; increase access to higher education for all students; provide skill enhancement and induction-program opportunities for teachers; and encourage parental and community involvement in education.

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