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Texas, We Have a Problem

The Math/Science Education Deficit and the Need for High School Reform

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The Soviet Union's launch of Sputnik in 1957 served as a wake-up call to the United States. With Sputnik, the Soviets demonstrated technological superiority to the U.S., prompting America to immediately invest in recruiting mathematicians and scientists, and upgrading math and science education. As a result, the U.S. landed the first man on the moon just 12 years later.

Unfortunately, that positive math and science momentum was fleeting. Nearly 50 years later, the U.S. has slipped near the bottom of industrialized countries in mathematics and science achievement, and Texas has not fared much better.

Until recently, the U.S. maintained the growth of its math and science labor force by importing students, scientists, and engineers from around the world.[1] But now increased national security has limited the country's ability to admit foreigners—the U.S. issued 20 percent fewer visas for foreign students in 2001 than in 2000[2]—and those who do study in the U.S. often return to thriving research environments and economies in their own countries.[3]

America can no longer rely on other countries to fill its gaps in math and science education; instead, the U.S.—and Texas, in particular—must work to improve achievement in math and science among our own children.

Policy Recommendations

- Clarify and strengthen TEKS so that it forms a solid foundation for math and science K-12 education.
- Improve the rigor of TAKS so it may serve as an effective measurement tool at all levels of achievement.
- Attract a greater supply of qualified math and science teachers through differentiated pay.
- Demand higher quality educational research through the use of randomized experiments.
- Research best practices in math and science education, and pursue widespread implementation.
- Continue to facilitate mutually beneficial partnerships between primary and secondary education, higher education, and industry.

Identifying the Problem: The Math/Science Education Deficit

In 2004, China graduated about 500,000 engineers and India 200,000—in comparison, the U.S. graduated only 70,000.[4] This is no surprise, considering fewer than 5 percent of American college graduates

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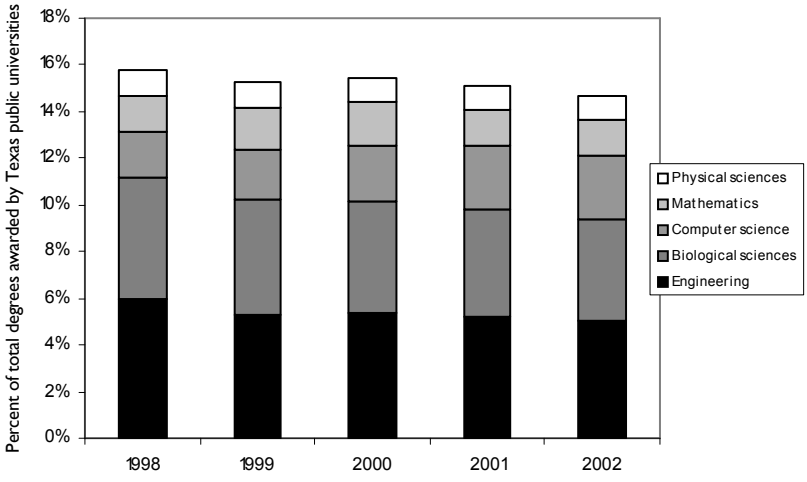
earn science or engineering degrees compared to nearly 40 percent in China.[5] In fact, the percentage of U.S. undergraduates pursuing engineering is the second lowest among developed countries.[6] By 2010, it is estimated that 90 percent of scientists and engineers in the world will live in Asia.[7]

Unfortunately, current trends do not offer much hope for America. In 1966, more than 35 percent of the country's bachelor's degrees were awarded in science and engineering fields; by 2001, that number had dropped to less than 32 percent.[8] The graduating class of 2001 marked the lowest percentage of bachelor's degrees in engineering, at 4.7 percent, since 1977.[9] Texas follows similar trends. Despite a rise in the number of computer science graduates, the percentage of science, technology, engineering, and math (STEM) degrees awarded by Texas public universities has declined in recent years.[10]

STEM degrees awarded by Texas public universities, 1998-2002



Source: Texas Higher Education Coordinating Board data

While the share of STEM graduates declines, the number of jobs requiring STEM training continues to grow. According to the National Science Board, the number of science and engineering jobs in the U.S. is growing almost 5 percent each year—three times the rate of all occupations. At the same time, the average age of scientists and engineers is rising, and a mass exodus is expected when the baby boomers reach retirement age in the next several years. As mentioned earlier, the U.S. can no longer rely on foreigners to take positions left unfilled by Americans—the number of VISAs issued for foreign students has declined, and the growth in science and engineering jobs in other countries has outpaced that growth in the U.S. As the National Science Board writes, "These trends threaten the economic welfare and security of our country."[11]

Why are we falling so quickly behind? All indicators point to American K-12 students' lack of preparedness in math and science. Until recently, it was commonly accepted that U.S. fourth graders performed above the international average, but that their performance declined consistently throughout high school. However, in late 2005 researchers at American Institutes for Research discovered the error in this line of reasoning, declaring previous comparisons inferior since different groups of countries had participated in the various grade levels' tests. When comparing the U.S. to countries that only participated in all three math assessments—the fourth and eighth grade TIMSS, and the PISA at 15 years—the U.S. performed consistently poorly at all grade levels. Out of 12 industrialized countries taking part in the three tests, the U.S. finished 8th, 9th, and 9th, respectively.[12] And not only do most countries outperform the U.S., but they do so while spending far fewer dollars per student. For example, Korea—a nation that only recently rose above third-world status—spends about half what the U.S. does per student, yet far outperforms us in math and science.[13]

American performance in math and science certainly gives cause for alarm, but where do Texas students stand? Unfortunately, the picture is no better for Texas. On the National Assessment of Educational Progress (NAEP), 25 percent of Texas eighth graders exhibit proficiency in math, and 23 percent in science—versus national averages of 36 percent and 42 percent, respectively. While Texas is a national leader in the percentage of high school students taking at least one upper-level math course (59 percent), only 29 percent of high school students take an upper-level science course, compared to a national average of 41 percent. And while 81 percent of American secondary school students are taught by teachers with a major in their subject, only 58 percent of Texas students can say the same.[14]

The struggles continue for Texas college-bound students. In 2005, Texas students posted the 5th lowest score in the nation on the math section of the SAT,

and the average SAT score in Texas has dropped one point over the past 10 years, during which the nation's average score has increased by 18 points.[15] On the ACT, Texas fared only slightly better, ranked 11th from the bottom in science and 14th from the bottom in math.[16] Only 63 percent of Texas students transition directly from high school to college—the 9th lowest rate in the nation.[17] Further, half of Texas college students must take one or more remedial classes,[18] and only 49 percent of full-time students complete a bachelor's degree within six years of college entrance, versus a national average of 64 percent.[19]

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Put together, these facts leave as no surprise that only 26 percent of Texans aged 25 to 65 have a bachelor's degree or higher, and 23 percent do not even have a high school diploma.[20] While the state's high population of immigrants may help explain these low figures, Texas is still in need of a more highly educated workforce. Nineteen of the 25 fastest-growing occupations in Texas require some post-secondary education, with half requiring at least a bachelor's degree.[21]

If Texas is to successfully compete with other states and the rest of the world in a global economy, we must improve and broaden the math and science pipeline from which our future leaders will emerge—and that pipeline starts in K-12 education.

Math/Science Education in Texas

According to a company-sponsored survey cited on Raytheon's website, 84 percent of students surveyed would rather do one of the following than their math homework: clean their room, eat their vegetables, go to the dentist or take out the garbage.[22] While the fact is humorous, it's telling: considering that statement, it's no wonder American students aren't choosing to pursue math-related fields at the rate they once were. Another survey reveals a more startling fact: 45 percent of public secondary students would be "really unhappy" in a career that required doing a lot of math or science.[23]

It is uncertain whether American students' poor performance in math and science leads to negative feelings about the subjects, or vice versa, and the truth probably lies somewhere between the two. Regardless, reforms are needed in math and science education in order to both improve student achievement in the subjects, and increase the number of students who choose to pursue those fields beyond high school graduation. Several of the shortfalls contributing to the math/science deficit in Texas public schools, as well as reforms needed to shrink that deficit, are outlined below.

Curriculum

The Texas Essential Knowledge and Skills, or TEKS, is the state curriculum for Texas public schools. The TEKS serves not only as the basis for classroom instruction, but also as the starting point for textbook publishers, and is the core material tested by the Texas Assessment of Knowledge and Skills (TAKS). Unfortunately, an analysis by ACT found that the curriculum lacks specificity and likely promotes mastering lower-level skills, thus leaving students unprepared for post-secondary education.[24]

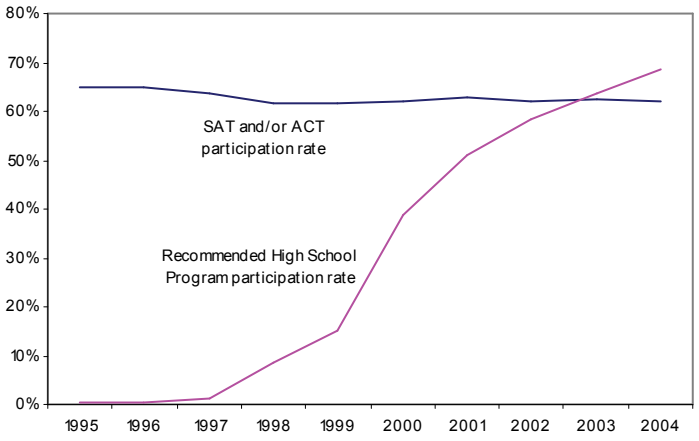
In a recent examination of state science standards by the Thomas B. Fordham Institute, the Texas standards received an "F"—the third worst score in the country. One reviewer surmised, "the writers of the physical science sections know very little of the subject beyond the fourth-grade level."[25] The Texas Education Agency responded by saying that the report included suggested lesson plans that are not created or mandated by the state,[26] but Fordham replied that Texas would have at best received a "D" without the additional materials.[27] Unfortunately, the Texas math curriculum did not fare much better, receiving a "C" in Fordham's 2005 report, partly due to an overemphasis on "technology and marginal, time-wasting activities."[28]

The high school curriculum—including what is studied, how much of it, and how intensely—is the best predictor of whether a student will obtain a bachelor's degree. In fact, curriculum is a better indicator of post-secondary success than socioeconomic status, standardized test scores, or high school GPA, and improvement in curriculum, or "opportunity-to-learn," can play a significant role in closing the achievement gap for some minority groups.[29] However, according to a recent report by Achieve, Texas does not yet hold public schools accountable for graduating students ready for work and college.[30]

Beginning in 2004-05, the requirements for graduation from Texas public high schools were raised to the Recommended High School Program. As the new default curriculum for Texas public school students, the Recommended Program is more academically rigorous than the Minimum curriculum, requiring more classes in mathematics, science, and other core subjects. In 1999, only 15 percent of students graduated under the Recommended Program, but that number jumped to 68 percent by 2004.[31] Soon, nearly 100 percent of high school seniors will graduate under the Recommended curriculum.

Unfortunately, graduation under the Recommended Program does not guarantee college readiness. In fact, in 1997 nearly 60 percent of students in the Recommended High School Program did not demonstrate college readiness[32]—a fact likely contributing to the high need for remediation among Texas college students. And despite the rising number of students graduating under the Recommended Program, the percentage of students taking the SAT and/or ACT—which are admission requirements for most colleges and universities—has decreased over the past 10 years.[33] As mentioned previously, Texas students have shown no positive progress in SAT scores over the past 10 years.[34] Clearly, the "college-ready" curriculum is insufficient for today's Texas high school students.

College prep curriculum and SAT/ACT participation rates



Source: AEIS data and TEA report

Due to the adoption of the Recommended Program as the standard curriculum, Texas students are taking more college-prep courses than ever. But insufficient college readiness shows that while the quantity of those courses has increased, the quality is still lacking and/or inconsistent throughout the state. As the backbone of nearly every class taught in Texas public schools, TEKS must set clear, rigorous standards in order to ensure consistent, quality courses for all Texas students.

TEKS must be clarified and the public school curriculum strengthened if Texas schools are to successfully prepare students for post-secondary education and careers in the 21st century.

TAKS

Although Texas students' TAKS scores have steadily increased over the past several years, the TAKS may not be the best measure of student achievement. While 82 percent of Texas fourth-graders exhibited proficiency on the Math TAKS in 2005,[35] only 40 percent exhibited proficiency on the National Assessment of Educational Progress.[36] This discrepancy between the Texas and national tests is one of the largest in the nation. In fact, in a recent evaluation of the strength of state proficiency standards, Texas received one of the three lowest grades in the country.[37]

Until the TAKS test was implemented in 2003, Texas students took the annual TAAS test. One major concern with TAAS was its emphasis on minimal competence, which essentially placed a low ceiling on scores and made it impossible to gauge the progress of the highest-achieving students. So while average scores increased, the performance of top students may have stagnated or even decreased.[38] While TAKS has likely improved in this regard, there is still insufficient evidence of its ability to track the highest performers.

Another concern is the low standards set for accreditation of Texas schools. In order to be rated Academically Acceptable, schools must meet minimum passing rates on the TAKS. Unfortunately, these thresholds are incredibly low, especially in math and science. Schools must demonstrate a 50 percent passing rate in reading, writing, and social studies in order to be rated Academically Acceptable. Unfortunately, passing rates of 35 percent on the math TAKS, and 25 percent on the science TAKS, are also deemed Acceptable.[39] If schools are held to such low standards, how can students be expected to perform much better?

TAKS must reach sufficiently high standards of difficulty so that the performance of students at all levels of achievement can be properly assessed, and greater performance expectations must be placed on schools to encourage higher student achievement.

Lack of Qualified Teachers

Teaching quality is one of the most important factors determining student achievement.[40] Recruiting and retaining high-quality math and science teachers should therefore be of utmost importance to Texas public school administrators. Unfortunately, the current pool of math and science teachers is lacking, both in quality and quantity.

On average, U.S. math and science teachers scored 557 on the mathematics section of the SAT, well below the average score of 593 for math or science majors who are not teachers. The difference is even greater when looking at math teachers alone, who scored 56 points below non-teaching math majors (568 versus 624).[41]

Despite research showing a positive relationship between teachers' subject matter knowledge and student learning gains,[42] many math and science classrooms in Texas are staffed by teachers without a certificate in the subject being taught. About one-fourth of middle school math and science teachers, and 65 percent of high school computer science teachers, are teaching out-of-field.[43] Administrators are often forced to hire out-of-field because of shortages in math and science teachers. Of the 39 states reporting teacher shortages for a 2002 National Association of State Boards of Education brief, 31 reported a shortage of math teachers and 30 reported a shortage of science teachers.[44] And while only 3.6 percent of Texas teachers were uncertified in 1996, that number grew to 11.7 percent just six years later.[45]

These numbers are not surprising considering the system by which teachers are paid. Because of the use of single salary schedules throughout the country, teachers are paid the same regardless of the subject or grade level taught, and without regard for effectiveness. In other words, an ineffective elementary teacher is paid the same as an excellent high school chemistry teacher of the same seniority. Considering the higher starting salary a math or science expert could draw in the private sector—$50,000 as an engineer, versus $30,000 as a teacher—it is no wonder that so few decide to teach.[46]

Teacher pay in Texas must be modernized and professionalized, so teachers are paid their true market value based on expertise and results.

Other Math/Science Classroom Concerns

Since the early 1990s, the "math wars" have raged among educators, researchers, and parents. On one side are the "traditionalists," who favor an instruction-centered approach where students memorize and practice basic skills. On the other side are the "constructivists" who believe in a discovery-centered approach to student learning. Despite calls for a "cease-fire" nearly 10 years ago, the battle continues today.[47] A similar discussion centered on inquiry-based learning has spilled into science instruction.[48]

Math constructivists advocate the widespread use of calculators, even in the early grades.[49] Referring back to the AIR study where U.S. fourth-graders were outperformed by students in seven out of 11 countries, it is interesting to note that calculators are prohibited in more than half of the fourth-grade classrooms in those 11 countries. In comparison, only 31 percent of American fourth-grade teachers disallow calculator use.[50]

Another concern is the sheer amount of material covered in American math classrooms. In order to satisfy educators in 50 different states, textbook companies include as many topics as possible. As a result, the American middle school curriculum covers between 27 and 32 topics each year compared to 21 to 23 topics in other countries.[51] U.S. students may cover a wide array of topics, but the time given to understand each one is severely limited.

In general, the quality of research in education has deteriorated. Randomized experiments comparing an experimental group to a control group are a staple of quality research. Unfortunately, the percentage of education studies based on randomized experiments has decreased over the past two decades, in favor of qualitative or "feelings-based" research.[52] Researchers must re-shift their focus to high-quality randomized experiments so that Texas educators and policymakers can rely on this research when making positive reforms.

Math/Science Deficit Solutions

In 2000, the Texas Higher Education Coordinating Board published *Closing the Gaps by 2015* with the

primary goal of increasing higher education enrollment by 500,000 students by 2015. *Closing the Gaps* also set goals specific to math and science: increasing the number of students completing STEM degrees and certificates by nearly 15,000 per year, certifying 3,000 math and sciences teachers per year, and securing an additional $400 million per year in federal science and engineering research funding to Texas institutions of higher education.[53] A cost-benefit analysis of the plan estimates that *Closing the Gap*'s primary goal of increasing higher education enrollment by 500,000 students will produce a net economic benefit of $274 billion.[54]

Unfortunately, the 2005 *Closing the Gaps* progress report shows mixed results. Texas quickly surpassed the goal of certifying 3,000 math and science teachers per year (due mostly to the increase in alternatively certified teachers), and is well positioned to reach its goal on securing research funds. However, the state fell far short of its 2005 benchmark in increasing the number of students completing technology-related degrees, achieving only one-third of the targeted goal.[55] Texas must pick up the pace in order to reach its goal of 29,000 STEM graduates by the year 2015.

By passing Senate Bill 353 in 2001, the Legislature created the Texas Engineering and Technical Consortium (TETC), a "consortium of companies, higher education, and the State of Texas formed to increase the number of engineering and computer science graduates in Texas."[56] Through TETC, funds are awarded to colleges and universities for programs focused on increasing the number of engineering and computer science degrees conferred. Forty-seven grants totaling $10.6 million have been awarded to 23 public and private institutions in Texas.[57]

In December 2005, Governor Rick Perry announced the Texas Science, Technology, Engineering, and Math Initiative (T-STEM), a $71 million initiative to boost math and science education in Texas. The program, which is funded by a combination of public and private grants, will establish 35 T-STEM Academies across the state that will align high school coursework with post-secondary and workforce opportunities, aiming to increase the number of students who pursue math- and science-based careers. T-STEM will also establish a best practices network so successful models can be replicated across the state. The first T-STEM Academies are expected to open in time for the 2006-07 school year.[58]

The U.S. Department of Education administers a Mathematics and Science Partnership (MSP) grant program to increase math and science achievement among American students. MSP grantees work to enhance the skills and knowledge of classroom teachers by partnering with STEM faculty in institutions of higher education.[59] In 2005, Texas received nearly $17 million in MSP grants.[60]

Math/Science Pipeline: The Future of Texas

In his January 2006 State of the Union address, President Bush recognized the importance of improving U.S. math and science education by saying, "Our greatest advantage in the world has always been our educated, hardworking, ambitious people, and we are going to keep that edge."

In order to keep that edge, however, the United States and Texas must work to improve math and science education in grades K-12, so students are better prepared to pursue post-secondary education and careers in those fields. To accomplish this, Texas policymakers must work to improve the rigor of the state curriculum and assessments, recruit and retain more qualified math and science teachers, and utilize quality research to identify best practices and spur positive reforms. The private and public sectors must continue to form mutually beneficial alliances that facilitate strengthening the math/science pipeline, and secondary and post-secondary education must be aligned to increase the number of students who successfully transition from Texas high schools to colleges. Through the increased strengthening of the math/science pipeline—from elementary and secondary school, to higher education, and to the workforce—the economy and people of Texas will continue to prosper.

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