STAYING COMP

In a global economy many argue that America needs to emphasize science, technology, engineering and math in its schools.

BY HEATHER CHIKOORE

Move over reading, writing and 'rithmetic, a new acronym has taken the front seat in education. STEM (Science, technology, engineering and mathematics) is now the rage.

Heather Chikoore tracks technology, engineering and math education for NCSL.

Many recall the shock Americans felt when the Soviet Union launched the first satellite, Sputnik, in 1957, and the urgent push to ramp up our nation's ability to lead the world in scientific and technological innovation. Today, reports such as "Rising Above the Gathering Storm" by the National Academies of Sciences and books like *The World is Flat* by Thomas Friedman call for a renewed and equal effort in the 21st century.

"The vast majority of Americans, especially business and scientific leaders, still see the United States as the world's technological leader," says Bruce E. Bursten, president of the American Chemical Society, the world's largest scientific society. "But many see a great potential for our leadership to diminish or disappear altogether if our country is no longer turning out enough of

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the best and brightest scientists and engineers," he says.

Bursten says there is a strong consensus in the business, education and scientific communities that our nation's future competitiveness in the global marketplace is directly tied to our ability to prepare children to be innovators for the technological economy of the future.

SCIENCE, TECHNOLOGY, ENGINEERING AND MATH

But why the focus on STEM? Experts believe that in order for America to remain an economic leader in a global economy we must ensure that our citizens have strong skills in science, technology, engineering and math. Yet international comparisons of student achievement

Educating Graduates for Math and Science Jobs

Imagine an employee with a master's degree in biotechnology who is also trained to negotiate with the Food and Drug Administration, work on a patent law team and lobby Congress. Or someone who has a master's in forensic science and whose skills qualify her to lead teams of people and communicate complex information to the public. How do math and science students gain deep scientific knowledge and the business skills needed by today's scientific and technological industries? Many believe the professional science master's (PSM) degree is the answer.

Increasingly, businesses are seeking employees with skills in a STEM (science, technology, engineering and mathematics) subject who also have skills required for business, communication, policy or leadership. Some of the fastest-growing and highest-paying jobs require scientific or mathematical prowess and the ability to apply that knowledge in a real-world setting.

The professional science master's degree is designed to allow graduate students to pursue advanced training in science or mathematics, while also developing skills highly valued by employers. Programs consist of two years of academic training along with a professional component that may include internships and "cross-training" in business and communications.

"It's very important that Iowa keep highly skilled graduates in the state, rather than offering students an excellent education then discovering they go out of state for employment," says Iowa Representative Cindy Winckler. She says the five PSM degrees offered at University of Northern Iowa, ranging from biotechnology to ecosystem management, are designed to meet the needs of Iowa businesses and industry. Students see science and math concepts implemented in a real-world setting through internships. "These are graduate students who are receiving high-paying jobs, often in Iowa, when they graduate," she says.

Professional science master's degrees are currently offered by more than 100 programs at more than 50 institutions in 25 states and the District of Columbia. There are currently more than 1,300 students enrolled, with more than 500 degrees awarded each year. Approximately 85 percent of these graduates are U.S. citizens, and, unlike many traditional math or science degree programs, more than half (54 percent) of the graduates are women.

As lawmakers emphasize education policy to enhance economic and workforce development, professional science master's degrees could become an integral part of the agenda. The start-up costs of the degrees are relatively low and the programs are often self-supporting. To learn more go to www.sciencemasters.com, or contact Heather Chikoore at NCSL.

in math and science intensify concern about the United States' ability to remain competitive. The 2006 Program for International Student Assessment indicates that American 15-year-olds test 21st among 30 developed countries on science literacy and 25th on math literacy.

"It's interesting—and perhaps hopeful—that our 4th graders seem to do pretty well compared to their international peers in math and science," says Bursten. "By high school, however, their performance has fallen off. They are losing their interest in science somewhere along the way."

Business and industry leaders worry that too few students have a deep understanding of these subjects and are ill equipped to fill future jobs. According to the National Science Board, almost 30 percent of students in their first year of college must take remedial science and math classes. Few U.S. students major in and complete a degree in science, math or engineering.

China and India graduate math and science students in large numbers. Coupled with their low wages, they have a distinct advantage in attracting business ventures.

Very few women and minorities pursue math and science education or careers. In 2000, African Americans held only 4.4 percent of the science and engineering jobs and Hispanics only 3.4 percent. Women make up more than half of the college students in the nation, but represent little more than one quarter of the science and engineering workforce.

The requirements of the No Child Left Behind Act have led to intense focus on math and reading in schools across the country, at the expense of science, engineering and technology curricula. The Center on Education Policy report, "Choices, Changes, and Challenges: Curriculum and Instruction in the NCLB Era," found that 62 percent of school districts increased the amount of time spent in elementary schools on English language arts and math, while 44 percent of districts cut time on science and other subjects.

The National Science Board suggests policymakers focus on providing a streamlined system of science learning from preschool through graduate school, and ensuring an adequate supply of well-prepared and highly effective teachers. The Business Roundtable has organized 16 leading business and technology associations in an effort to double the number of science, technology, engineering or math graduates with bachelor's degrees by 2015. The Partnership for 21st Century Skills, an organization that includes the business community, education leaders and policymakers, argues that students are not gaining the skills they will need to succeed in the new global economy. It recommends that lawmakers place an emphasis on encouraging information, media and technology skills.

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STATES TAKE ACTION

Responding to this call for action, legislatures are considering policies that could improve education in these fields.

Kentucky's Education STEM Task Force, comprising government, business and education leaders, developed an action plan to improve science, technology, engineering and math education in preschool through college. A March 2007 report, "Kentucky's STEM Imperative: Competing in the Global Economy," says "there is a national and state-level crisis … that must be addressed immediately." It calls for a statewide curriculum "aligned with global workforce and academic standards."

Other states have focused primarily on higher education. In 2007, New Mexico lawmakers established the Alliance for Underrepresented Students at New Mexico State University, with the purpose of promoting science, technology, engineering and mathematics education and retention at the undergraduate and graduate level for minority and female students.

REPRESENTATIVE
RICHARD LINDSEY
ALABAMA

Many states focus on K-12 education, often seeking to increase the number of teachers and improve their skills.

Alabama has placed an emphasis on improving math and science instruction. Since 2002, Alabama has funded the Alabama Math, Science and Technology Initiative (AMSTI) to improve math and science teaching and achievement statewide.

"In Alabama, the Army's Redstone Arsenal and NASA's Marshall Space Flight Center need engineers, yet a large number of engineers employed in the United States are coming from other countries. We want our students to be competitive in that field," says Alabama Representative Richard Lindsey.

Participating schools are chosen in a competitive process, and send all math and science teachers to two weeks of training at a summer institute for two years. Teachers learn activities and strategies to teach the content mandated by Alabama standards. The schools are provided with all the math and science equipment and materials needed for hands-on activities in their classrooms. In addition, coaches provide follow-up training and support to the teachers in their class-

Math Education "Broken"

Established by President Bush in 2006, the National Mathematics Advisory Panel was charged with recommending the best use of research to improve the teaching of mathematics. The National Math Panel's final report, issued this spring, declared math education "broken." It contains 45 findings and recommendations on many topics including instructional practices, materials, professional development and assessments. Among the highlights:

- Students need a deeper understanding of basic math skills.
- Stressing concepts is as important as memorization and drilling.
- Math curricula in elementary and middle schools cover too many topics.
- Countries where children do best emphasize core topics in depth.
- Parents should have an "attitude adjustment" and stress to their kids the importance of math.

Worrisome STEM Indicators

When the National Academies released the 2005 report "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future," a flurry of activity at the national and state level followed. Alarmed by the stark picture the report painted of America's ability to remain a world leader in science and technology, federal and state policymakers began to intensify their focus on science, technology, engineering and mathematics education. Following are some of the worrisome indicators the National Academies identified:

- Fewer than one-third of U.S. 4th and 8th graders performed at or above a level called "proficient" in mathematics. About one-third of the 4th graders and one-fifth of the 8th graders were unable to perform basic mathematical computations.
- U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.
- In 1999, only 41 percent of U.S. 8th grade students received instruction from a teacher who specialized in mathematics; the international average is 71 percent.
- In Germany, 36 percent of undergraduates receive their degrees in science and engineering. In China, the figure is 59 percent, and in Japan 66 percent. In the United States, the figure is 32 percent.
- In 2004, China graduated about 500,000 engineers, India 200,000 and America 70,000.
- For the cost of one chemist or one engineer in the United States, a company can hire about five chemists in China or 11 engineers in India.

rooms as they use the new teaching methods learned at the summer institute.

"In many cases we simply have not had an adequate number of qualified teachers in science, math and technology. Teachers already in the system need additional training in order to teach students effectively," says Lindsey.

Schools participating in the program outperformed other schools "often dramatically," says Steve Ricks, state director of the initiative. Large test gains are important, but he believes changing the way students feel about math and science is just as important. "If you want students to enter math- and science-related careers, the first step is having them enjoy the subjects. Otherwise, they never give the career a first thought," he says.

Concern over a shortage of qualified teachers in math and science has led the Iowa legislature to provide $4 million in funding for a new teacher training center that would prepare college students to become math and science teachers through mentoring, training and real-world learning opportunities in the private sector. It would also recruit students and attempt to steer them into math and science teaching.

"Iowa has a significant need for STEM educators," says Representative Cindy Winckler. The state doesn't have enough teachers in the pipeline for the increasing demand when baby-boomer teachers retire. "Iowa schools of education have only about a dozen students ready to teach high school physics, but the state will have almost 100 physics teachers retiring in the next few years," Winckler says.

Other states have made sure the content and tools in classrooms are focused on science, technology, engineering and math. The "E" in STEM is often given short shrift. But Massachusetts has included engineering content in its state science requirements for grades K-12 since 2001.

Following the lead of Maine's groundbreaking middle school laptop initiative in the '90s, many states have initiated similar programs to ensure students are using current technology tools. Pennsylvania's Classrooms for the Future is the state's high school reform initiative that emphasizes technology as a tool in preparing students for college and the workforce. More than $20 million in state funds the first year provided participating schools with laptops, interactive white boards, webcams and a variety of other high-tech gadgets. Equally important was the training, support and professional development for teachers to integrate technology into teaching and learning.

REPRESENTATIVE CINDY WINCKLER
IOWA

THE DEBATES CONTINUE

Not everyone believes education should focus on science, technology, engineering and math with so much intensity. Many argue that the key to American competitiveness lies not only in scientific and technical prowess, but in a well-rounded education that encourages creative talents. Focusing on STEM subjects at the expense of history, art, music and foreign languages does students a disservice, critics believe.

Should we even be concerned about the shortage of STEM graduates? The National Academies report, "Rising Above the Gathering Storm," cites disturbing trends in the number of U.S. students earning engineering degrees compared to China and India. But researchers at Duke University dispute these statistics, finding that the definition of "engineer" is different from country to country and the quality of the engineering graduates in other countries isn't always equal to that of American graduates. Still, they acknowledge that China and India are increasing their engineering graduates at a more accelerated pace than the United States.

Is the United States really in danger of losing its competitive edge in a global economy? Education policy plays a role, but is it as important as monetary, trade or other policies that contribute to international competitiveness?

As long as American students continue to perform poorly on international tests, and employers continue to have problems finding highly qualified employees, the push to improve science, technology, engineering and math education is likely to stick around.

"The bottom line is that our graduates need to be prepared with the skills necessary to succeed in the technological economy of the 21st century," says Bursten. "This means well-rounded critical thinkers, problem solvers, and innovators who are equipped to deal with the challenges of an increasingly technology-driven world."

CHECK OUT maps, graphs and links on science, technology, engineering and mathematics debates at www.ncsl.org/magazine