

STEM education

SCIENCE TECHNOLOGY ENGINEERING MATH

Helping the Next Generation of Students Excel is the Goal of Boise State's Ambitious Programs

By MIKE JOURNEE

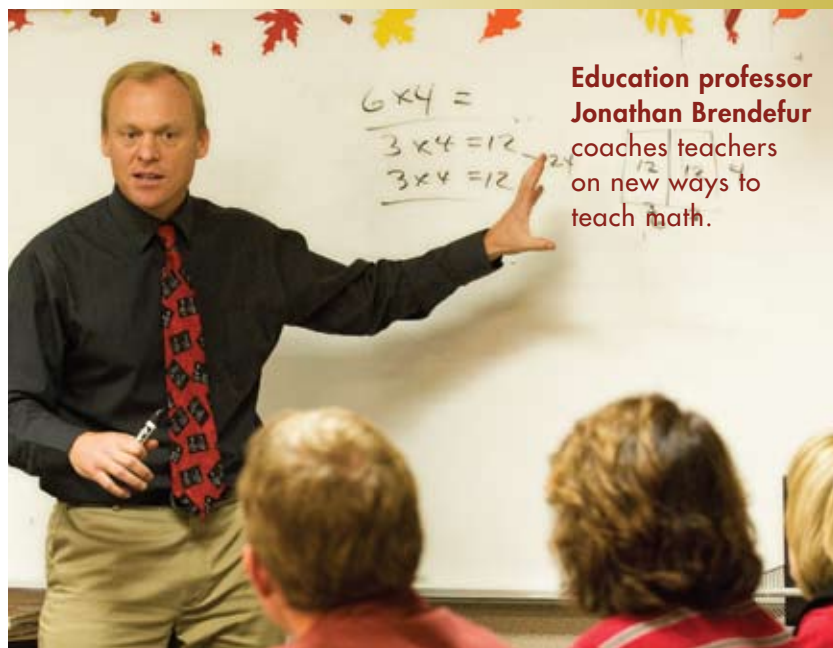
"I'm not a math person." It's an excuse we've all used or heard to justify a perceived inability to grasp the concepts behind not only mathematics, but also the sciences and many other technical subjects.

Educators see this well-worn justification not as symptomatic of a missing math or science gene. Instead, they see it as evidence of a generations-long breakdown in our educational system that has left students without the skills they need in our increasingly technological society.

"Everyone is a math person," said Jonathan Brendefur, director of Boise State's Institute for Developing Mathematical Thinking and professor of mathematics education. The problem, he and others believe, is that traditional textbook-based methods leave students, and sometimes teachers, with little context to make technical subjects either interesting or understandable.

The stakes for addressing this issue are escalating. The United States lags behind many developed nations in student performance on math and science tests, on the proportionate numbers of students pursuing technical fields at the university level, and on academic output as measured by published academic articles in the sciences and engineering.

"The next generation of scientists, engineers and teachers will play a critical role in the discovery and innovation that will help determine America's economic future," said Boise State President Bob Kustra. "It's imperative that we prepare our young people to succeed in these important fields."



Education professor Jonathan Brendefur coaches teachers on new ways to teach math.

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Meridian teacher Gay Lynn Erb utilizes math teaching skills she learned at a Boise State workshop.



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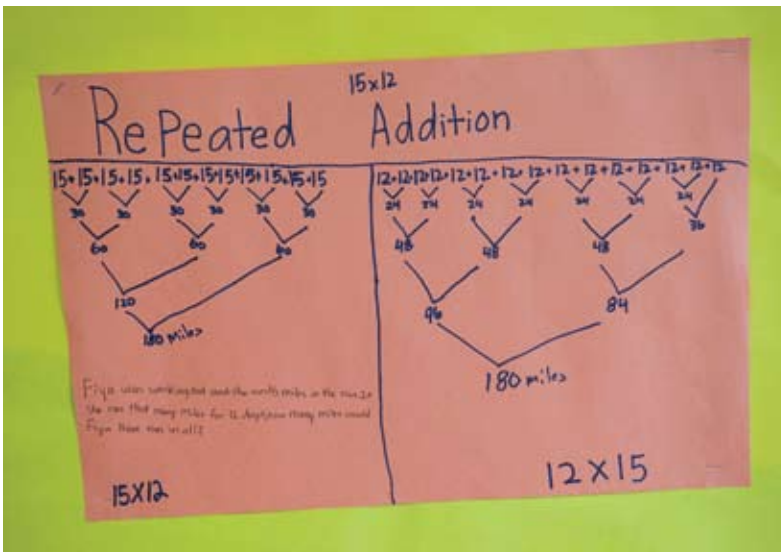
At its heart, the crisis is about a shortage of teachers qualified to teach what education scholars call STEM, short for science, technology, engineering and mathematics. Today's teachers often are asked to teach STEM-related topics despite having little, if any, formal training in the subjects. And qualified scientists seldom opt for teaching careers when more lucrative jobs await in the private sector. A recent survey of all secondary school principals in Idaho showed vacancies for at least 100 science teachers and 60

math teachers across the state.

An interdisciplinary team of Boise State administrators and researchers, including Brendefur, have teamed up to address these critical issues. With funding from many federal and state agencies, Boise State is engaged in wide-ranging efforts to provide current and future teachers with the knowledge and skills necessary to help students from kindergarten to college excel in STEM subjects. At the same time, the university is turning its eye inward to evaluate how it prepares and motivates talented students to excel in careers as math and science teachers.

"We need more qualified STEM teachers, and we want to give them the tools they need to succeed," said education professor Louis Nadelson, who is leading the Boise State research team. "Our goal is to identify and implement programs and strategies to make that happen."

Nadelson and his team are zeroing in on how students best learn STEM subjects and how to instruct teachers to effectively deliver their lessons. University programs ranging from in-service teacher workshops to science and engineer-



Hands-on exercises help students grasp math and science concepts.

ing camps to formal research partnerships with local school districts are being incorporated into the effort. Boise State researchers, some of whom have significant public outreach programs but little formal training in education methods, also are receiving support to develop their own research initiatives in STEM education.

The university's curriculum is being closely examined to leverage STEM opportunities. For example, an underutilized master's degree geared toward teachers interested in teaching Earth sciences is being retooled as a STEM education master's degree that will move from the College of Arts and Sciences to the College of Education.

"We are not creating this from scratch," said Sona Andrews, Boise State's provost and vice president for academic affairs. Andrews is leading one of Boise State's most recent STEM initiatives – a collaboration with the University of Washington, Oregon State University, Portland State University and Washington State University focused on doubling the number of STEM bachelor's degrees awarded to under-represented minorities within the next five years. "We're bringing together a lot of people and a lot of initiatives on campus that already are doing excellent work. It's a great fit," Andrews said.

Making STEM Make Sense

Nadelson and many other STEM educators believe a holistic approach to teaching technical subjects will enhance overall comprehension. For instance, by helping students understand their math lessons through the simple physics that keeps a paper airplane aloft or the forces that allow a bridge to hold a train, teachers can connect math's abstract formulas to the real world.

"It really goes to people's ability to problem solve," said Nadelson. "By approaching STEM topics in a unified manner, students learn how to approach the problems they face in their daily lives in a methodical, scientific way."

Since individual learning styles vary greatly, students also benefit by developing their own methods to tackle problems instead of being told how to do them, Brendefur added. He works with elementary and secondary teachers in Idaho and nine other states in the West and Midwest on a more comprehensive approach to teaching math.

"Rather than asking students to give me the an-

swer, I ask them to show me two or three ways to solve the problem," Brendefur said. "The answer is the same, but the way they get to the answer isn't."

The teacher acts as a facilitator to guide a student toward mastery rather than an instructor who issues specific directions. Many teachers, while eager, simply do not have the confidence and skills to handle this think-on-your-feet approach, which is why having someone like Brendefur to coach them is so crucial.

"Remember, most of us are products of the traditional way of teaching this subject," Brendefur said.

When teachers figure out how to incorporate these methods, the results can be remarkable. Students of elementary and middle school teachers from Caldwell and Meridian that Brendefur worked with six years ago have shown marked improvements in math proficiency test scores – from scores in the 40-60 percent range before Brendefur began the project to 90 percent proficiency after "reformed math" concepts were introduced.

"We used to think there's only one way to do math," said Gay Lynn Erb, part of this initial group of teachers who took part in Brendefur's project. "It's really about mathematical reasoning, and there's more than one way to approach it."

Today, Erb heads up the Meridian School District's efforts to improve math teaching techniques. Earlier this year, she was awarded the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring by President Barack Obama.

Erb said she worked hard to grasp the concepts Brendefur was presenting. "When I finally got it, it was almost terrifying," said Erb, who considers Brendefur a mentor. "I realized how much I really didn't know."

Educating the Educators

There are inherent obstacles to educating teachers to teach a certain way, then asking them mid-career to make substantive changes. Nadelson

and the Boise State STEM education group want to change the way educators are educated from the start.

"The teachers are the key – they are the superheroes," said Pat Pyke, director of education research for Boise State's College of Engineering and a member of the university's STEM education team.

Scholarships help. One recent U.S. Department of Education grant awarded to Boise State provides support for K-5 teachers to learn new STEM techniques through summer



Math tools such as number squares can enhance learning.

workshops. Another scholarship is funded through a grant from the National Science Foundation's Robert Noyce Teacher Scholarship Program and is designed to encourage talented students majoring in STEM areas to become K-12 math and science teachers.

However, real change in the way Boise State educates tomorrow's STEM teachers will come at the university level.

A key is Boise State's participation in the Science and Math Teacher Initiative program piloted by the Association of Public and Land-Grant Universities to help universities increase the quality, quantity and diversity of science and math teachers, particularly in high schools.

This network of 117 universities and university systems, which is funded by the National Science Foundation, is designed as an information sharing and planning collaborative. Boise State is among 27 members selected for a leadership position.

"Boise State was one of the first to step forward and say we want to be part of this," Andrews said. "This is where we will really have an opportunity to shape the national path forward on this issue. It's something that we believe can be an area of excellence for us."

Deans Cheryl Schrader of the College of Engineering, Diane Boothe of the College of Education and Martin Schimpf of the College of Arts and Sciences all have

"We need to show a new generation of America's best and brightest that teaching is a noble profession."

– Barbara Morgan, distinguished educator in residence and former NASA astronaut

taken an active role in the Initiative's deliberations – a sign of the strength of Boise State's commitment to STEM education and a reason for the university's leadership role in the program.

Boise State also is a lead institution in the National Science Foundation's Math and Science Partnership program. Engineering professor Amy Moll is principal investigator on the grant, which is aimed at encouraging statewide

collaboration. Boise State will work with the University of Idaho, Idaho State University, Discovery Center of Idaho, Idaho State Department of Education, Idaho National Laboratory and Micron Technology to collect data on the state's STEM-related programs as a step toward developing a proposal to achieve needed improvements.

"This will really help us get our arms around what challenges we face and what we need to do to address this issue in Idaho," said Nadelson, one of several co-principal investigators on the award.



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Boise State's Louis Nadelson, right, and the Discovery Center of Idaho's Susan Dittus compare notes as part of a study to learn how parents interact with children in informal science learning situations.

The Role of Research

The goals of STEM education efforts, which center on encouraging more talented students to become math and science teachers, thus increasing the number of STEM-proficient graduates, are well defined. But the best way to reach these goals has not been extensively researched. Boise State is helping fill that gap by examining the impact of each of its STEM-related programs and determining what practices work best.

Nadelson, for example, is working with the Discovery Center of Idaho to examine

how parents interact with their children in informal science learning situations. "We think that if parents interact more with their children, not only will the children get more out of it, but so will the parents. But we don't know that," he said. "We've made centers like these a priority around the country, but are they working the way we think they are?"

Boise State researchers from a broad range of disciplines are gathering in a STEM Scholars Research Group. With funding from Boise State's Division of Research, it's hoped that participants will form the nucleus of a STEM education research culture on campus.

"It's exciting to see the innovative and thoughtful ideas our STEM Scholars are bringing forward as part of their deliberate discussions," said Mark Rudin, vice president for research. "What could be better than to have your leading scientists, researchers and engineers trying to understand how they can further STEM in middle schools?"

Geosciences professor Karen Viskupic, the education manager for her department, considers the opportunity to meet with other faculty as part of the Scholars Group valuable on many levels. "For someone like myself, whose training is in science and has no education resume, this

Boise State STEM Scholars Ross Perkins, center left, Henry Charlier and Louis Nadelson discuss upcoming projects with colleagues who also are part of the STEM team.



CARRIE QUINNEY PHOTO

is an incredible resource," Viskupic said.

Viskupic is a co-principal investigator on a five-year National Science Foundation grant that supports fellowships for graduate students in the sciences, technology, engineering and mathematics to work with K-12 students and teachers to enrich STEM content in educational settings. Last year, the community outreach program engaged more than 7,000 K-12 students in southwest Idaho. Viskupic is incorporating STEM education techniques in the program and is conducting student surveys to gauge their effectiveness.

A Cultural Change

Ultimately, overcoming the nation's gap in technical leadership boils down to two things for Barbara Morgan, Boise State's distinguished educator in residence and former elementary school teacher and NASA astronaut. Morgan is a key member of the Boise State STEM team. Her position at the university was created to draw attention to the need for STEM reform in our education system and to help coordinate Boise State's STEM work.

While the efforts of Boise State, other universities, STEM-focused funding agencies and affiliated entities are a start, Morgan said the campaign demands a broader look at how our nation approaches education fundamentally.

"Education needs a national will to address its issues," said Morgan. "We're making a great start here at Boise State and elsewhere. I know our leadership

on this issue will begin to address the problem. But what I'd really like to see is a national discussion about teaching and why people go into teaching."

There is little incentive for people to go into teaching, a profession many believe to be overworked, underpaid and underappreciated, she said. Those priorities must change or all of the STEM work being done today will address only the symptoms of the problem.

"We need to show a whole new generation of America's best and brightest that teaching is a noble profession," Morgan said. "In my opinion, it is the most important profession for the future of this nation." ◆



CARRIE QUINNEY PHOTO

STEM educators review many books as part of efforts to develop effective strategies for teaching, including science and math textbooks used in K-12 classrooms.