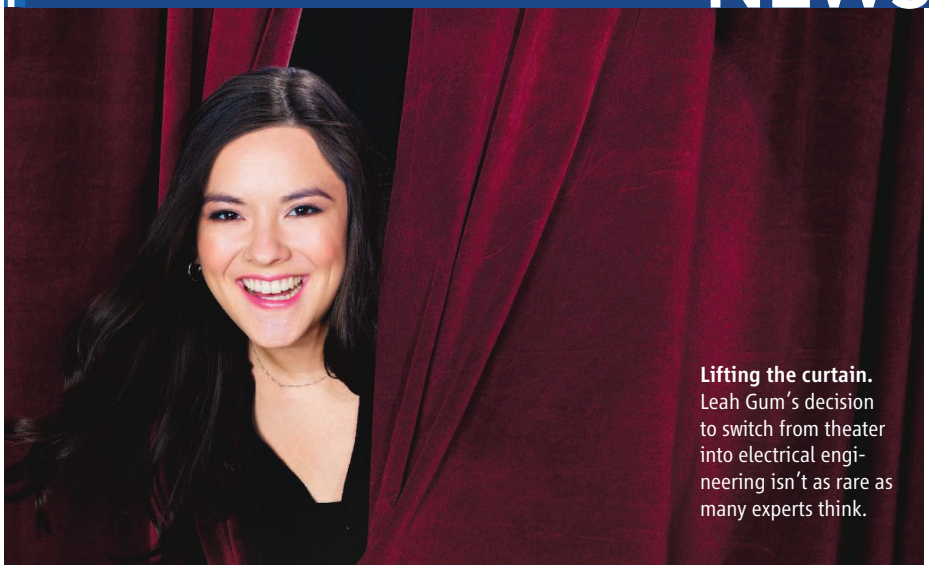

Lifting the curtain. Leah Gum's decision to switch from theater into electrical engineering isn't as rare as many experts think.

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SCIENCE EDUCATION

Studies Suggest Two-Way Street for Science Majors

To win acceptance to Cornell University, Will Najar had to convince the philosophy department that he would be a perfect fit for the program. But after taking mostly humanities classes in his freshman year, the 19-year-old Najar changed his mind. "I wanted to build things or help people," he says, "and I realized that I wasn't going to be able to make that kind of an impact on the world as a philosophy guy."

So Najar switched his major to biology. The change meant "working harder for lower grades," Najar says. But he persevered, and along the way he taught himself some computer and Web skills. After graduating last May, he snared a well-paying job as a technical account manager at Microsoft, where he uses his scientific training to help customers solve their computing problems.

Najar's academic path has long been thought to be an anomaly. Conventional wisdom holds that few college students ever transfer into a STEM (science, technology, engineering, and mathematics) field because they lack the necessary academic preparation. The field is already plagued by high attrition rates: At least one-half of students who declare their intention to major in a STEM field either switch majors or never earn a degree, some driven out by poor instruction and a chilly climate for women and minorities. Both the low inflow and high outflow have long been thought to be unique characteristics of STEM disciplines.

The unfortunate result, experts say, is a dearth of technically savvy workers that U.S. companies need to compete in a global economy. That alleged crisis has prompted the federal government, industry, and private foundations to spend billions of dollars trying to understand and reverse the pattern.

But new data poke major holes in that conventional wisdom. The findings could have important implications for an issue that for 2 decades has spawned bitter ideological battles between those who say that the leaky STEM pipeline is a national crisis and those who say that the supply of STEM workers is more than adequate.

One study, a first-ever look at attrition rates outside the STEM fields, has found that STEM majors are no more likely to switch out than are students in the humanities, business, and education. In November, Xianglei Chen of RTI International in North Carolina reported on her analysis of a nationally representative sample of 19,000 students who began college in 2003.

The study, which tracked the students for 6 years, found an attrition rate of 48% for STEM majors (20% dropped out and 28% switched to a non-STEM major). That compares with 56% for initial humanities majors and 50% for business majors. "We've never really looked at attrition in non-STEM fields, so we never really knew the comparative size of the problem for STEM," says Matthew Soldner of the Education Department's National Center for Education Statistics, which commissioned the RTI study.

A second study, also released in November, looked at how student preferences change during their first year of college. The data, from the Beginning College Survey of Student Engagement (BCSSE) and the National Survey of Student Engagement, involve 78,000 students at 119 institutions in 2012. Researchers at Indiana University found that 24% of the students who entered college with plans to earn a STEM degree had shifted into a non-STEM field by the end of their freshman year. But they also discovered that 27% not originally planning to major in STEM had switched into a STEM field by spring.

Those two findings come as no surprise to Hal Salzman, a professor of public policy at Rutgers University in New Brunswick, New Jersey. Salzman's previous work has questioned those claiming a shortage of STEM-trained workers. And in a new paper not yet in print, Salzman argues that the leaky STEM pipeline metaphor should be replaced by a two-way street, with students continually moving into and out of STEM disciplines.

"If you talk to 17-year-olds about their plans, or ask adults how they got into their profession, you'll find that their interests change and they change majors," Salzman says. "I think what has happened is that we defined [attrition] as the problem, and that led researchers down a certain path." Salzman thinks educators should focus on understanding the factors that affect whether students stick with any given major, including STEM.

Talking back

The push to improve U.S. science education across the board dates from the post-Sputnik era. But it was a 1997 book by Elaine Seymour and Nancy Hewitt, *Talking About Leaving: Why Undergraduates Leave the Sciences*, that made undergraduate STEM education a hot research topic. In lengthy interviews with 335 students at seven U.S. institutions, the authors found, as one reviewer put it, that "students are very disappointed with college [STEM] courses and professors."

The book was a call to arms for improving how STEM courses are taught and attracting and retaining more women and minorities, all with the goal of stemming the high attrition rates. (Seymour and Hewitt pegged the rate at 55% for their diverse sample of colleges and research universities.)

For 2 decades, that philosophy has ruled: A 2012 report by a White House science

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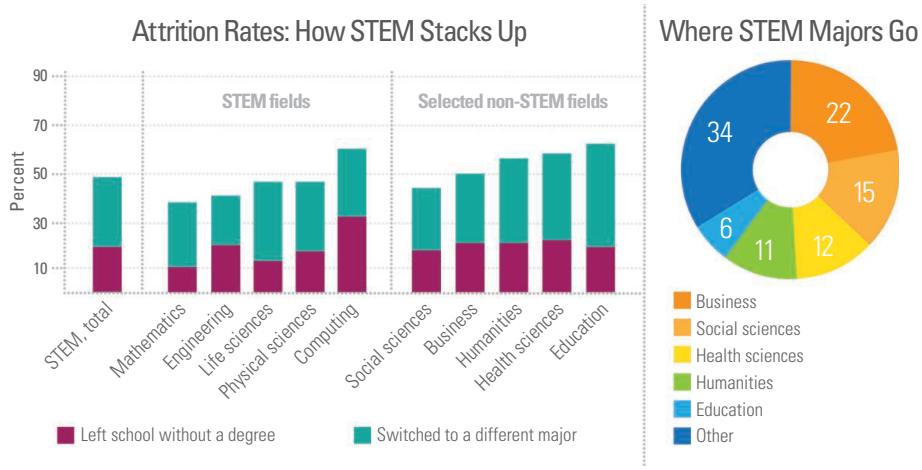


Changing majors. Attrition rates are no higher for students in STEM fields than in the humanities, education, and business, and business is the most popular destination for STEM majors moving into a new field.

advisory panel, for example, concluded that the single most effective way to preserve U.S. competitiveness would be to lower the STEM attrition rate in college. The National Science Foundation and the Alfred P. Sloan Foundation are even funding a follow-up to the original study, tabbed *Talking About Leaving Revisited*, aimed at understanding why efforts to retain students in STEM majors haven't made a dent in attrition rates.

But the new studies suggest that efforts to reverse the outflow have ignored a critical factor: It takes time for students to find their way before ultimately choosing a major that's right for them. "We need to develop programs to help students gain a better understanding of the broad array of educational and career options before them," Soldner says.

Those involved in the follow-up to the 1997 study think the RTI data make an important contribution to the debate but don't reduce the importance of efforts to attract and retain students in STEM fields, including a strong focus on women and minorities. "Just because the attrition rate is no higher doesn't mean there isn't a problem," says Joseph Ferrare of the University of Wisconsin, Madison, co–principal investigator on the follow-up study. "And ensuring diversity is also important."

Few would argue with the need to make the STEM workforce more diverse. But the studies provide no clear guidance on where to focus attention. Chen finds, for example, that women are more likely than men to switch majors, while men are more likely to drop out—but only among those seeking bachelor's degrees. (The RTI study included those enrolled in associate degree programs as well.) Looking at racial and ethnic differences, she finds that fewer Asians than blacks switched out of STEM majors but that there was "no measurable difference" in the rates among Asians, whites, and Hispanics.

The influx documented by BCSSE raises a new question: How can institutions trying to grow their STEM programs tap into a potentially much larger pool of talent on college campuses? Leah Gum, who entered the University of Southern California in Los Angeles in 2009 as a theater major, says she is living proof of how to bridge that gap.

"An actor is all I ever wanted to be," Gum says. But after devoting the first semester to courses on her craft, she decided that a career in theater "wouldn't be satisfying in the long run." She also longed for a greater intellectual challenge—what she calls the "academic side" of college. She switched tracks and is now in the last year of a combined, 5-year bachelor's–master's degree program in electrical engineering. After graduation she will join Apple to work as a sensor engineer in their human interfaces devices group at the company's headquarters in Cupertino, California.

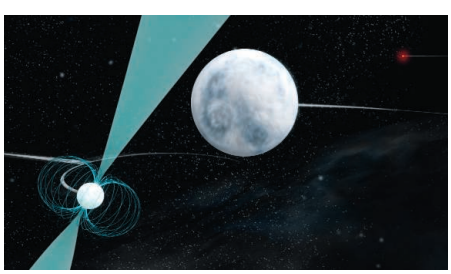
"Most people think there's no overlap between being an artist and being a scientist," she notes. "But I disagree. Actors are always trying to understand what motivates their character. And thinking about how people behave translates directly into engineering, where the human-machine interaction is so important." **–JEFFREY MERVIS**

ASTROPHYSICS

Rare Celestial Trio to Put Einstein's Theory to the Test

In a cosmic coup, astronomers have found a celestial beacon known as a pulsar in orbit with two other stars. The first-of-its-kind trio could soon be used to put Einstein's theory of gravity to an unprecedented test. "It's a wonderful laboratory that nature has given us," says Paulo Freire, a radio astronomer at the Max Planck Institute for Radio Astronomy in Bonn, Germany, who was not involved in the work. "It's almost made to order."

A pulsar consists of a neutron star, the leftover core of a massive star that has exploded in a supernova. The core's intense gravity squeezes atomic nuclei into a single sphere of neutrons. The spinning neutron star also emits a beam of radio waves that sweeps the sky as steadily as the ticking of an atomic clock. Tiny variations in the flashing



Ménage à trois. A pulsar (*left*) and one star (*center*) are orbited by a more distant star (*right*).

can reveal whether the pulsar is in orbit with another object: As the pulsar cycles toward and away from Earth, the pulse frequency oscillates. Roughly 80% of the more than 300 fast-spinning "millisecond" pulsars have a partner.

But a single partner couldn't explain the peculiar warbles in the frequency of pulsar PSR J0337+1715, which Scott Ransom, an astronomer at the National Radio Astronomy Observatory in Charlottesville, Virginia, and colleagues discovered in 2007 with the Robert C. Byrd Green Bank Telescope in West Virginia. Training other radio telescopes on the object, Ransom and colleagues monitored it almost constantly for a year and a half. Eventually, Anne Archibald, a graduate student at McGill University in Montreal, Canada, figured out exactly what's going on.

The pulsar, which has 1.4 times the sun's mass and spins 366 times a second, is in a tight orbit lasting 1.6 days with a white dwarf star only 20% as massive as the sun. A second white dwarf that weighs 41% as