

Two-year colleges teach physics to widening range of students

Increasingly, partnerships ease the way to transfer to universities.

Thomas Carter admits that teaching at a two-year community college was never his goal. But Carter—who served in the US Navy, earned a PhD in particle physics, was a postdoc at Fermilab, and worked at Lucent Technologies before joining the faculty at the College of DuPage in Glen Ellyn, Illinois—says he “can’t imagine a more rewarding job.” Why? Because of the focus on teaching and the students’ motivation, he says.

Across the US, there are more than 1000 community college campuses and about 1700 full-time faculty who teach physics. Like their four-year counterparts, two-year colleges vary widely. Some serve several hundred students in rural locations while others have enrollments in the tens of thousands. According to the American Association of Community Colleges, enrollment is increasing, although the proportion of all undergraduates who take at least one class at a two-year college has been fairly constant at 45% for more than a decade.

“I think [community colleges] are playing more and more of a primary role for the first two years of college,” says Dwain Desbien, who in 2001 launched the physics program at Estrella Mountain Community College in Avondale, Arizona. “One reason is flat-out cost. Community colleges are roughly 10 to 12 times cheaper. Another reason is that universities are capping enrollments as their funding is declining. It’s harder to get in.” Add to that the attraction of smaller classes—at community colleges classes are often limited to 24 or 30 students, compared with hundreds in introductory physics at large universities—and the growing number of arrangements

that facilitate transferring to a university to complete the bachelor’s degree, and it’s easy to see why prospective students would consider community college.

Many hats

Beyond preparing students to transfer to four-year schools, most community colleges offer training for jobs in areas ranging from physical therapy to wind-turbine repair; physics is a requirement for certificates and associate’s degrees in many such areas. And, as at four-year institutions, physics courses at two-year colleges serve students majoring in other science, technology, engineering, and math (STEM) fields.

Bachelor’s students at four-year institutions may take classes at a community college if they need to repeat a course, desire to fill a gap in their knowledge, or want to shorten their overall time to a degree. Having them sample community college classes is “a nice thing,” says Desbien. “It makes it easier to get enough students for third-semester calculus-based physics.” Some engineering departments at four-year institutions even advise their students that taking physics courses at a local community college is a better choice than staying on campus. In addition, a growing number of high school students are supplementing their educations at two-year colleges.

About a quarter of the 500 000 students who took trigonometry- or calculus-based introductory physics in the 2011–12 academic year did so at a community college, according to the Statistical Research Center of the American Institute of Physics (which publishes *PHYSICS TODAY*). In the combined undergraduate classes of 2013 and 2014, some 13% of new physics bachelor’s degree recipients had begun their educations at a community college; for freshly minted physics PhDs in 2014 that figure was 11%.



Measures of success

It’s more common for students at two-year than at four-year colleges to juggle outside responsibilities such as family or work, be the first in their families to go to college, or not be native English speakers. The stereotype that students who enroll in community colleges are less well-prepared than their counterparts at four-year universities has some basis in reality, says Desbien. But “if you provide support and caring, they catch up. My goal is to make them more prepared.” He spends the first week of class “creating community among students.” By the end of their second year of physics, Desbien’s students complete a project such as building a speaker system or a rocket out of household products. “The vast majority in the calculus-based sequence go on to a four-year college,” he says.

“I hear back all the time from students that they are better prepared than their classmates who started off at a four-year institution,” says Martin Mason, a physics and engineering professor at Mt. San Antonio College in southern California. When students transfer to neighboring Cal Poly Pomona, he says, “their grades go up”—a measure of the two-year college’s rigor. About a dozen students a



TO DEMONSTRATE KINETIC ENERGY AND INERTIA, Tom Carter breaks a cinder block over his brave colleague, Dave Fazzini. Most of the hammer's kinetic energy is absorbed in an inelastic collision with the block, the inertia of which saves the sandwiched professor from the nails in the upper board. The demonstration is for a class in conceptual physics that Fazzini teaches at the College of DuPage in Illinois.

year transfer to the likes of Caltech, MIT, and the University of California, Berkeley, to pursue physics or engineering, he adds. That's out of an annual 150 to 175 transfer students, most in engineering and a handful in physics.

Two-year college faculty pride themselves on being nimble. "Educating our students is our sole goal," says Carter. "If someone proposes something that looks better, we want to move. If I want to change something in a lab session, the only person that needs to be involved is me. If I am willing to put in the time, within limits, I can make it happen." In physics many instructors switched to a hands-on, combined lecture-lab approach years ago, notes Marie Plumb, who retired in 2012 from teaching physics at Jamestown Community College in New York. "Some instructors refuse to do any lecturing at all," she says.

Such flexibility is useful when tuning classes for workforce certification. "Almost half of our students don't plan to get an associate's degree or to transfer to

a four-year institution," says James Heath, head of physics at Austin Community College (ACC) in Texas. His department worked with the sonography department in ACC's health sciences division to develop a one-semester course that gives aspiring sonographers the physics grounding they need "instead of forcing them to take two semesters of general physics."

A lack of respect

If physics faculty at two-year colleges have a complaint, it's that their departments have to rely too heavily on adjunct faculty, who are hired on a class-by-class basis. Many adjuncts are devoted teachers, but they typically don't have offices, so students can't drop in on them easily. Paid little, they may be running from one gig to another to make ends meet, and they do not become integrated into the college community. "Full-time professors have an investment in their students and in the school," says Plumb. "The system abuses part-timers."

The reliance on adjuncts varies among institutions. On the high end in physics is Mt. San Antonio College, with 4 full-time professors and 13 adjuncts. Not having the budget to hire more permanent faculty, says Mason, means he spends a lot of time with administrative tasks like hiring and training adjuncts.

Another complaint is a perceived lack of respect by four-year institutions. For example, says Heath, some institutions have different standards for transfer students from two-year versus four-year colleges. "They accept a B or better from us, but from any four-year college they will accept a C or better," he says. "And that's despite the fact that our instructors have PhDs and have years of experience. Teaching is not held in high regard. It's insulting."

Partnerships

To facilitate the transfer of credit between two-year and four-year public institutions, most states have adopted guidelines that specify which courses will be accepted. That helps faculty at two-year institutions plan courses and advise students. But state oversight can also be a straitjacket: A two-year college may want to offer an engineering class, for example, only to find that nearby universities won't give students credit for it.

Recent legislation in North Carolina has STEM faculty at the state's community colleges chafing: As of 2014 only the first semester of astronomy and no courses in chemistry for nonscience majors count as required classes in the University of North Carolina system; other courses transfer as science electives. Since students typically prefer to take a full year for credit, many of the state's community colleges will stop offering those subjects, says Joe Heafner, a longtime professor at Catawba Valley Community College in Hickory and current chair of the American Association of Physics Teachers committee on physics in two-year colleges.

On the upside, two-year community colleges are increasingly creating partnerships with four-year institutions. At the college or state level, some four-year schools guarantee admission to community college students, grades permitting. University faculty sometimes teach third-year physics or engineering courses at community colleges. And it's common for faculty members at community



STUDENTS ADJUST THE MOUSETRAP-POWERED CAR they designed and built in an applied physics class at Cloud County Community College in Kansas.

colleges to forge personal relationships with faculty at nearby universities; such relationships can help students find research internships and transfer to a bachelor's program. The funding for such internships often comes from outreach activities the university researchers have written into their grant proposals.

For the past few years, the engineering college at the University of Illinois at Urbana-Champaign has promised ad-

mission to students from eight community colleges in the state if they successfully complete required coursework. Although Carter says only a few students at the College of DuPage take that route, he describes the program as "a game changer" because it demonstrates trust in the college's quality of education. "We went from teaching one or two sections of engineering physics a year to teaching 8 or 10. Our engineering enrollment

went up by a factor of three or four," he says.

Texas A&M University has launched something similar, but with a twist: Its own faculty teach engineering courses at partnering community colleges around the state. Funded by Chevron with \$5 million over five years, the Texas A&M-Chevron engineering academies grew out of discussions after the President's Council of Advisors on Science and Technology projected in 2012 that the nation will need 1 million more people with STEM degrees in the next decade and a related prediction by the Texas Workforce Commission that the state will need 62 000 engineers by 2022.

Students in the program are enrolled in both institutions from the get-go, with activities built in for them to feel part of the Texas A&M culture. For example, says Jacqueline Perez, the university's director of engineering academies and workforce development, "They can come to fun things like football games and tailgates. And career offices and other resources are open to them." Students take a year or two of engineering at their local community college, taught by Texas A&M faculty at Texas A&M prices. Other classes required for an engineering major—physics, math, and so on—are taught by community college faculty at lower tuition.

The goal is for each of the five partner community colleges to enroll 100 students a year in the program. "We are leveraging two-year institutions across the state. They are seeing more and more students, and they have a more diverse student body," Perez says. The first program started last year in Houston, followed by one this fall in Dallas; partnerships in Austin, Brownsville, and San Antonio will begin enrolling next fall.

Some faculty from other two-year colleges around the country are skeptical about the Texas A&M model. To them, it sends a message of distrust in the academic level of community college courses. They are also concerned by the higher fees students have to pay. But Heath of ACC, one of the Texas A&M partners, says, "The idea is to tap into a new reservoir of students. Hopefully it will bring more students into our foundational courses. Most importantly, it will give our students another avenue to pursue a better life. That's the biggest benefit."

Toni Feder



THIS MARBLE SORTER, made by students at Houston Community College-Spring Branch, represents an antiviral delivery system for stemming an Ebola outbreak. The project was for a class taught by Jacques Richard (front right) as part of the Texas A&M-Chevron Engineering Academy, a partnership between the two-year college and Texas A&M University.