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AWAKENING THE MASTER

It doesn't seem to matter how many teaching awards and grants we accumulate or how important we are made to feel, science faculty are still scrambling to get students and to keep them. Innovative teaching must have big shoulders to attract interest, engage the intellect, and sustain individuals who find the route to the baccalaureate degree and beyond to jobs in science, unacceptably bumpy and long.

Broad-based Structure

Pima Community College now has over 60,000 students, approximately 25 percent of whom are in career tracks and about 40 percent in transfer programs. My job includes introducing physics to everyone who can benefit—which, to my way of thinking, is everyone. Since our West Campus physics faculty consists of just three members, our strategy involves seizing opportunities to teach physics "units" in a wide array of courses taught in other departments. We find ourselves designing physics lessons for students in liberal arts, education, health professions, psychology, even philosophy; and we are called upon to teach such general education courses as Science, Society and Technology.

Occasionally, we hook someone. In any given semester we might have 15 students (of 60,000) who look as if they may follow us in our professions. Of these, seven or eight will form a coterie. Although they may have very different bents—e.g., engineering, astronomy, or mathematics, once they have covered the basics we allow them to prescribe independent study topics that they agree on, such as advanced mechanics, tensor theory, or even general relativity. These students are not looking for the credit hours; they simply want to learn more. Occasionally, work in one of these courses will lead to a research project at the University of Arizona and, eventually, a thesis.

[Once Pima students show promise and tenacity in science, we steer them into the Summer Bridge Research Program—our 1991 innovation that has enabled approximately 18 students each year to work in University of Arizona laboratories for eight to 10 weeks. Continuous funding from the National Science Foundation has given this opportunity to more than 150 of our community college students, 90 percent of whom have gone on to earn a bachelor's degree.]

Role of the Conference

We are pleased and proud that so many of our graduates are doing well. Still, we're very concerned about those excellent students who at some point decided to back off from a lab science, which can be a time-consuming endeavor. Some of the barriers we know are very real. There are children to look after, demanding work schedules, family crises. Maybe they get a job offer they cannot refuse. Other barriers, however, such as self-doubt, are imagined and could be surmounted with an "assist." Occasionally, we work on someone's sagging spirits and help with an unsolved demon math problem until the light comes on.

For many students it isn't math that scares them off; it's having to get up in front of others to talk about their ideas. One strategy gives promising students, including some who are "at risk," a boost in this arena. A colleague and I established the International Conference on Fundamental Physics to invite four or five budding physicists from each institution to give papers during a weekend retreat, at a cabin which we have dubbed Willow Creek Research Center. It is our intention that every student we prepare for a career in physics be familiar with, if not adept at, the tradition of oral presentation.

Once each semester we caravan up to the cabin, traveling 16 miles on winding roads through rugged canyons and spectacular rock formations, ascending from the desert floor to pine forests at 6000 feet. Sandwich ingredients are laid out on a rustic countertop, the projector is set up, and a sheet is hung over a clothesline rope. Then we lunch, look out the windows at birds and squirrels, and chat informally until one o'clock—the time set for the conference proceedings. Our formal welcome makes clear to the students that they have all the qualities it takes to join us in this very important endeavor.

Their talks are on diverse topics—"knot theory," the shortcomings of "the chain rule," the shapes of electron-positron collisions, science education, or the hierarchy of claims to the invention of the Theory of Relativity. All presenters are expected to use overheads, but they have varied delivery styles; some are awkward, some dry, others quite effective. The question periods are long enough to allow the professors to make a point or two and model disciplined thinking in research. The rest of the weekend is loosely structured, though we talk physics constantly, even as we hike to Lizard Rock, a prominent landmark that after six conferences is associated with achieving excellence.

But it is not easy to get every top student this far. It is typical for two or three of the selected students not to show up at the conference, after all. This is our frustration and our challenge.

Confounding the problem, those of us teaching science and math are spread very thin. To do our best for students, one of the most important activities outside of the classroom and lab is staying abreast in our fields—which often leads to more commitments of time. A few years ago I joined a company of peers at the University of Arizona who were having stimulating weekly discussions on gravitation, which led to our hosting an international conference that broke ground with 30 papers on, ironically, the neglected subject of time as it applies in physical cosmology. Outcomes were the validation by renowned scientists around the world and the establishment of the Joint Center for the Study of Time (JCST). We have held a colloquia series for the past three years, which has generated increased interest and become yet one more way to expose our students to the community of scientists.

Role of the Tutor

The community college is a critical stage in a student's development and a great environment for coaching and guiding. Our students are incredibly diverse; we could never know them as anything but unique individuals, explorers of society and of themselves. Since community college students often are the first in their families to seek degrees and, typically, have jobs, they are more likely to attend college on a part-time or intermittent basis, slowly working toward their goals. Many are mature students, in some ways on a par with their professors. This allows a certain comfort level for discussion outside of class.

Karen Beeson was a beautician and a single mom when she returned to Pima Community College with an interest in engineering. She was good in math but was afraid of physics. Before she enrolled in my class, she came to me and said, "I don't know…I hear you're too hard." I told her she could not let fear ever become a barrier to what she wanted. She joined the class, but nearly every day she would come to my office and express her doubts. Ms. Beeson became an outstanding graduate. She has established a scholarship at Pima Community College specifically for students like herself, those whose unrealized potential must be coaxed out with huge doses of encouragement.

Reach and Stretch

It is a nourishing fact that we always have students who are so excited about physics that they request special classes. They are our guides. But a handful is too few to keep American science from slipping behind. We know that our grooming of scientists has to begin earlier. Our major outreach effort is an attempt to improve the image of physics. Physics "Phun Nite" is a public program that packs a lecture hall on either the UA or PCC campus (alternating semesters), during which we present classroom experiments in entertaining ways—often with unexpected results! For example, we generate electricity from lemons, crush cinder blocks on a bed of nails atop a bare-chested professor, electrify lights from our mouths with high-voltage sparks from a Tesla coil, and illustrate chain reactions in nuclear energy with mousetraps and ping-pong balls.

No one knows for sure how enthusiasm for Physics Phun translates into recruitment of students to our field. And any amount of success in recruitment, we now see, is not the end of our worries about having engaged students. The shortcomings of American high school graduates who want to go into science are all too apparent. It's not just that they are weak in math or they have never had to make a presentation; often their weaknesses in reading and writing are a deterrent to comprehension. So though we are able to mentor students in science and can coach them through periods of self-doubt, there is much more that can be done.

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