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GETTING A HEAD START

Programs introduce undergraduates to laboratory research in their freshman year

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TEST DRIVE Purdue students check out new modules for bringing authentic research into the first-year chemistry lab.

COURTESY OF GABRIELA WEAVER

Because some educators believe that it's never too early to get students involved in research, new programs are introducing students to research as early as their freshman year.

For example, the National Science Foundation's Chemistry Division launched an experimental program two years ago called [Undergraduate Research Centers](#), according to Richard D. Foust Jr., a program officer in the division. Aimed at freshmen and sophomores, the URC program complements the agency's Research Experiences for Undergraduates program, which tends to attract rising juniors and seniors ([see page 37](#)). NSF especially hopes to reach those students who start their education in community colleges, where they are unlikely to have access to research experiences. The centers will foster partnerships between research universities and community colleges, serving as places for students to do research and as models for other institutions that want to expand undergraduate research.

In its first round of funding for the URC program, NSF awarded 20 planning grants to give recipients the resources to further develop ideas that they could incorporate into proposals for fully funded sites. Full sites receive up to \$2.7 million over five years: \$500,000 per year plus a \$200,000 instrumentation grant in the first year.

Proposals for the second round of URC funding were due earlier this month. There is enough money to fund up to five URCs, Foust says.

In the first round, the only site that received full funding was the [Center for Authentic Science Practice in Education \(CASPIE\)](#). CASPIE is a collaboration among Purdue University, four predominantly undergraduate universities, and four community colleges in the Chicago area. Gabriela C. Weaver, an associate professor of chemistry at Purdue, heads the center. Research scientists and community college faculty affiliated with the center write research-based laboratory modules that are suitable for use both at research universities and at community colleges.

Institutions will be able to implement the modules in a variety of ways. At some of the

member schools, research modules will completely replace the traditional labs, whereas other schools will use part of the semester to teach students laboratory skills leading up to the introduction of research projects. The modules are designed to last six to eight weeks, or about half the semester.

Unlike the traditional approach to undergraduate research, which requires students to make a commitment outside their normal class schedule, CASPiE will bring research into the mainstream curriculum for general and organic chemistry.

"The important thing is that it's part of the regular curriculum," Weaver says. "We don't want students to have to sign up for a different course or a summer project. We want them to get the research experience as part of the normal courses they sign up for."

Weaver emphasizes that CASPiE is focused on "authentic science practice" and not just inquiry-based learning. "In inquiry-based learning, students are often pursuing a question we already know the answer to," she says. "In authentic science practice, we will let students experience what goes on in the life of a scientist in a research laboratory."

THE STUDENTS will get a taste of real research by generating data that will be applicable to their professors' work. "Even the researchers who write the modules don't have the answers when they write them," Weaver says.

Currently, the modules are being written and tested. All the projects involve research on topics that the students can relate to their everyday lives, such as the antioxidant capacity of foods. Weaver has recruited students from Purdue's freshman chemistry class to test-drive the modules in a special topics course. Piloting will continue over the summer. "We want to make sure everything is laid out correctly and that the modules are robust before implementing them in a classroom," Weaver says. "The last thing we want to do is expose students to a half-baked idea, an educational reform that hasn't been tested."

Purdue will offer the modules in one section of the general chemistry lab in the fall. "Before we scale up, we need to do it at a level that we know we can handle," Weaver says. "We also want to gauge the level of student demand."

Weaver doesn't intend to produce a lab manual as CASPiE's final product. "In five years, a lab manual would be useless," Weaver says. "We are intending to produce a process" that shows other researchers how they can use their own research to write laboratory modules.

To make sure that its programs are properly evaluated, CASPiE has hired an external assessor from the School of Education at Indiana University, which is not one of CASPiE's partner institutions. "We did that so it would be clear that we're getting an objective evaluation," Weaver says. "His job is to evaluate the program based on the goals that we specified in our grant and based on the activities that we're going to be carrying out."

While the goal of CASPiE is to bring authentic research into the classroom, another type of program gets freshmen involved in research outside the classroom. For example, the University of Pittsburgh is in the second year of its [First Experiences in Research program](#), which is modeled after the Undergraduate Research Opportunities Program at the University of Michigan.

Chemistry professor [Joseph J. Grabowski](#) heads Pitt's program--which is open to second-term freshmen--in his role as the director of undergraduate research for arts and sciences. In the program, students work on faculty research projects for five to 10 hours per week, either for academic credit or for payment as part of a work-study program. In addition, they participate in biweekly meetings with other students in the program. At the end of the term, students present their research in a poster session.



TEAM MEMBER Angela Minnici is one of three students currently working in Grabowski's lab as part of Pitt's First Experiences program.

COURTESY OF JOSEPH GRABOWSKI

Last year, 36 students participated in the program. This year, 55 students signed up. "We'd like to be able to meet the needs of every student seeking an undergraduate research experience in their second term as a freshman," Grabowski says. "Right now, we have more people applying than we can find faculty spots for."

MORE MENTORS are needed, but Grabowski doesn't believe that every student will want to participate. "We're not going to push 100% of freshmen to do this. I don't think it's appropriate," he says.

Grabowski helped ease the crunch this year by taking on three freshmen in his lab. His project was originally intended for just one student, but so many people were interested that he expanded the project into a team effort. The students are doing parallel experiments on different compounds. They are using triple-quadrupole mass spectrometry to investigate ions formed by silylated organic compounds.

Grabowski's students are already learning about the surprises of science by generating unanticipated results. "One experiment was just supposed to be a confirmatory experiment for something else," he says, "yet it turned up something entirely unexpected."

Programs such as Pitt's First Experiences and CASPiE have multiple purposes. "We know that undergraduate research can improve the retention of students," Grabowski says. "We could not think of a reason this would not benefit the students. They would be more engaged on campus. They would start developing those one-on-one relationships with faculty that we all want them to have. They would take more ownership of their education."

From the faculty's perspective, students who are introduced to research as freshmen are more productive when they participate in the more typical undergraduate research programs in later years. "Students starting younger become much more valuable team members as juniors and seniors," Grabowski says.

At this point, Pitt isn't planning to track whether the students declare majors in the department where they did their First Experiences project. "When we list the projects for the First Experiences program, we deliberately put them in a random order, and we do not say that this is natural science or social science or humanities," Grabowski says. "We try to maximize the possibility that they'll see other kinds of research that they could be involved in, not just natural sciences, when they start looking at projects."

For CASPiE, the goals are more explicitly related to chemistry. "Nationally, we lose the largest fraction of chemistry majors between the first and second years," Weaver says. CASPiE wants to retain more of those chemistry majors, especially women and underrepresented minorities. The education literature suggests that CASPiE's approach, based on collaborative science that is relevant to the students' everyday lives, is positively correlated with raising the interest level in groups that are underrepresented in the sciences.

The other objective is learning, but not simply the factual content of courses. "We will be providing the students with experience about an aspect of science that generally is absent in their undergraduate curriculum: how to think about science," Weaver says.