THE CHRONICLE
of Higher Education

With NSF Support, Research Moves Into Science Labs of 2-Year Colleges

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Andrea Hook (left) and Jessica Prame work with James A. Hewlett, their biology professor at Finger Lakes Community College, to test their method for extracting and purifying a protein. The college has a grant from the National Science Foundation to foster undergraduate research at two-year colleges.

By Dan Berrett

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Phil Longyear and his laboratory partner were just a few minutes into their experiment, but they had already gotten ahead of their fellow biology students here at Finger Lakes Community College.

When their classmate Carey Phillips walked over to their lab table, they found out why.

"Did you guys heat your samples?" she asked.

"No," Mr. Longyear answered. "Oh. Darn."

He and his lab partner had skipped a vital step in testing the process they designed to isolate, copy, and purify a protein from the venom of southern copperhead snakes that is thought to have cancer-fighting properties. They forgot to heat their sample, a process that denatures proteins and allows them to be separated by molecular weight.

Mr. Longyear turned to his partner, Kasie Tierson. "You want to run this one and see what happens?" he asked, pointing to the unwarmed sample. She nodded.

"What's cool about this is we'll get to see the effects of the heat," he said. "It's the spirit of research: experimentation."

That spirit is central to their course, "Introduction to Biological Manufacturing I," and to the pedagogical philosophy of their teacher, James A. Hewlett, a professor of biology at Finger Lakes. A $3.35-million grant from the National Science Foundation will enable Mr. Hewlett's project team to run workshops for 16 community colleges nationwide. The grant will pay for their supplies, equipment, faculty and curriculum development, and stipends for student research assistants. The goal is to give students of biology in community colleges the chance to do research on open-ended, real-world questions with no predetermined answers—and experience all the rewards and frustrations that come with that work.

"If we're teaching people to be scientists," Mr. Hewlett says, "we have to let them be scientists."

Many four-year institutions have come to see that undergraduates should be given the chance to do complex, hands-on projects that go beyond the cookbook-style experiments found in traditional introductory science labs. Such open-ended research projects are widely thought to confer educational benefits because they pique students' curiosity, expose them to more-authentic ways of engaging in scientific inquiry, and allow them to work closely with faculty members. The National Research Council of the National Academies, in its 2003 report on changing the teaching of biology, recommended that all students be encouraged to conduct independent research "as early as is practical in their education."

And many scientists cite their own undergraduate research experience as a reason they chose to pursue careers in science. "It wasn't a PowerPoint lecture that got me interested in being a biologist," Mr. Hewlett says.

Rare Opportunities

At community colleges, however, such opportunities are rare. While the National Survey of Student Engagement asks students at four-year institutions how often they conduct research with a faculty member (about one in five do, according to the 2011 report), a similar survey of community-college students doesn't even ask the question. And among the members of the Council on UndergraduateResearch, a group that promotes collaborative research and scholarship between faculty and students, less than 2 percent come from community colleges.

As they seek to encourage more students to pursue careers in science, technology, engineering, and mathematics, the so-called STEM fields, policy makers and educators are recognizing that community colleges, which teach nearly half of all undergraduates, need to be more effectively included in the effort.

Sparking interest in science among this group of students can help create more doctoral-level scientists many years from now. But that is not the only reason to focus on those students, says Francis Q. Eberle, executive director of the National Science Teachers Association. The nation also needs to increase its supply of technicians to work in such science-based fields as health care, information technology, and energy, he says. Such workers will need a bachelor's, master's, or associate degree to enter the labor force—and those earning two-year credentials, in particular, could use more-engaging educational experiences in STEM disciplines.

"That's a much larger population that needs it," Mr. Eberle says. "The community college plays a very important role in showing them they can participate in these fields."

But several barriers keep community-college students from having the chance to do research, says Nancy H. Hensel, a former executive officer of the Council on Undergraduate Research who has also studied the issue.

Research is expensive and time-consuming for colleges, and it is a lower priority in tenure and promotion decisions in this sector than at four-year institutions. Faculty members at community colleges also tend to carry heavy teaching loads and do not need to be as up-to-date on the latest developments in their fields as their peers at research-intensive institutions.

But such factors can be an asset in efforts to expose community-college students to open-ended research, says Ms. Hensel. Faculty members can take more risks because they are not under the same pressure to publish as their colleagues at four-year institutions.

"If they don't get the results, the students still learn, and that's the important part," she says.

Trustees also tend to be skeptical. When community-college presidents tell their trustees that they want to dedicate more resources to research, they often hear, "You're a teaching institution, why are you doing research?" she says. "They don't realize research is part of teaching."

Logistics also complicate matters. For many undergraduates, original research is conducted outside of class. Community-college students tend to have busier out-of-class lives than their peers at four-year institutions. More than half of community-college students attend classes part time, compared with less than a quarter of those at four-year institutions, according to the U.S. Department of Education.

Mr. Hewlett's project holds particular promise for changing the way community-college students learn biology, says Ms. Hensel, because it creates opportunities for them to do original research while they are in class.

Such research will not take place at all course levels, though. Colleges participating in Mr. Hewlett's grant program will use case studies in their introductory-level classes,where students will read about and replicate how people have used experiments to answer real-world questions. For example, one case has students play the role of a reporter for a sports magazine, where they analyze the chemical composition of energy drinks to determine their biological effects and evaluate the truth behind their marketing claims.

In intermediate-level courses, such as the one Mr. Longyear and Ms. Tierson were taking, biology students are given an objective, and have the freedom to design their own processes to get there.

And in advanced classes, students will do more open-ended research, often in partnership with local businesses or government agencies. At Finger Lakes, some students have tracked the movements and genotypes of black bears; others have studied how various lubricants transmit bacteria during massage therapy for people with compromised immune systems.

Doing that kind of research forcesstudents to think about which information is valuable and which is not, and how to best find it, says Mr. Hewlett. For example, his biological-manufacturing students had to choose the best method for sorting the snake-venom protein: by size, strength of charge, or structure. Each method has its strengths and weaknesses. Some are crude but less expensive; otherstake more time but yield more-precise results.

"The point of this class is to make us think like a pharmaceutical company," Mr. Longyear said.

Early Promise and Pushback

The impetus for using case studies and exposing students to original research came about nine years ago, when Mr. Hewlett realized that his own lectures were starting to bore him.

After adopting these methods, his courses became more interesting. Other benefits occurred, too: He was able to form relationships with scientists outside the college, and to feel more a part of the larger discipline.

But Mr. Hewlett says that teaching in this way also pushes him to work harder. He cannot refer to the same lecture notes from one year to the next. Instead, he has to devise meaty problems for his students to solve, and to anticipate all the ways their efforts can go awry.

Mr. Hewlett has a hunch that his research-infused courses lead to more enduring gains in learning, and the NSF grant will pay for researchers at the Social and Economic Sciences Research Center, at Washington State University, to evaluate the project's effects.

Initial evidence is promising. In 2004 he published a study in the Journal of College Science Teaching that looked at how biology students scored on an exam on evolution. Students in courses with traditional lectures answered 76 percent of the questions correctly, which was essentially the same score earned by students taught through the case-study method.

The big difference came a year later, after the study was published. On a whim, Mr. Hewlett and his colleagues retested a small number of students from each group. Students who had been enrolled in traditional lecture courses got 60 percent of the questions right. Those who had learned through case studies retained more of what they learned, with their score dropping only four points, to 73 percent.

The size of the sample was small, and the researchers did not control for external factors, Mr. Hewlett says, which renders the results far from conclusive. "We hesitate to get too excited, but it's certainly an interesting result."

Still, Mr. Hewlett's approach to using research as a teaching tool has not been universally embraced, even at his own institution. He estimates that four out of 10 faculty members who teach biology choose to use case studies and original research in their teaching, as do two of the 10 instructors in the natural-resources-conservation department.

Some, like Clinton D. Krager, an assistant professor of biology, see the merits of using Mr. Hewlett's methods, but only in moderation or in combination with lectures. "Some students are going to learn better with a traditional lecture, and some learn through case studies," he says.

Mr. Krager also worries that spending time delving deeply into one project does not leave enough time to cover the necessary breadth, particularly at the introductory level. And he argues that the typical public-school education does not adequately prepare students for learning through case studies because the method requires students to marshal material before they have been exposed to it long enough to truly grasp it.

But Mr. Hewlett says those methods still allow faculty members to cover all the bases. "We're not trying to remove anything from introductory courses, but to replace it with better pedagogic material," he says. "They're still getting what they need for general biology, but they're getting it in a more engaging way."