NEWS

Student Research: What Is It Good For?

More and more undergraduates are working in labs and out in the field. But what's the point? After decades of blind faith, educators are finally beginning to investigate what makes for a good research experience

Andrea Martin took off for Jamaica's Discovery Bay after completing her junior year at the College of Wooster. But the geology major wasn't there to have fun in the sun after a grueling academic year. Instead, she and two other Wooster students spent 10 days collecting 125,000-year-old pieces of coral reef and rhodoliths. Then they lugged them back to Ohio to begin independent study (IS) projects on characterizing the change in sea levels during the last interglacial warming period.

Martin loved the long, hot days prying fossils from the carbonate formations under the watchful eye of Wooster geology professor Mark Wilson, who has analyzed a well-dated erosion surface in the Bahamas from the same period. She hopes to earn a doctorate in paleontology or sedimentology and then become an academic. "I can picture myself as a professor at a place like Wooster," she says. But it wasn't the crystalline waters of the Caribbean, or the fact that she attends one of a handful of U.S. colleges where undergraduate research is a requirement for graduation, that sold her on the discipline. "I've wanted to be a geologist since the fourth grade," she says, "starting with the 'rock hound' program at my elementary school. When it was time to go to college, I looked for schools with strong geology programs. I didn't find out about the IS requirement until after I had applied."

When educators talk about the value of undergraduate research, they often cite students like Martin and programs like Wooster's. Many working scientists have fond memories of undergraduate days spent in the field or in the lab—including Wilson, who graduated from Wooster in 1978 and came back because he liked the way the school blends undergraduate teaching and research. And the ranks of undergraduate researchers are growing: A recent survey of 136 liberal arts colleges found that the number of students engaged in some type of research had risen by 70% in the past decade, while those pursuing more intensive summer projects had grown by 40% (*Science*, 13 July, p. 193).

Undergraduate research is equally popular among the major research universities. "Research is the lifeblood of our institution, and it's a good way to connect our faculty and students," says Hank Dobin, associate dean of the college at Princeton University, which requires all seniors to conduct a research project. It's even become a cottage industry: Undergraduates have started several journals in recent years to showcase their work and to learn the nuts and bolts of scientific publishing (www.jyi.org).

But what do students get from doing research? Would present-day scientists have chosen different careers if they hadn't done research as undergraduates? And how do their scientific achievements stack up against those of colleagues who missed the opportunity?

Rocky start. Wooster geology students Jerome Hall, top, and Sara Austin explore an exposure of broken coral, shells, and carbonate sand in Jamaica.

CREDIT: MARK WILSON

The answers aren't clear, because thorough evaluations are only now getting under way. "As an assumption, undergraduate research makes logical sense. But we have no idea what students actually learn from it," says Elizabeth VanderPutten, an education program manager at the National Science Foundation (NSF), which funds millions of dollars' worth of undergraduate research projects every year. "At the same time, it stands to reason that a poorly structured experience may be worse than none at all."

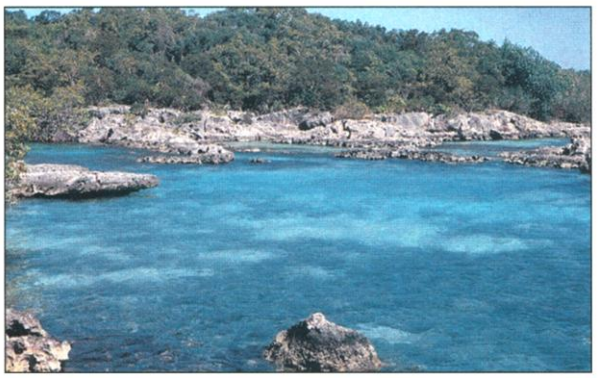
Defining a good experience

Educational researchers David Lopatto and Elaine Seymour are hoping that a 3-year, $650,000 grant from NSF will help answer some of those questions. Lopatto, a psychologist at Grinnell College in Iowa, and Seymour, a sociologist at the University of Colorado, Boulder, are interviewing students and faculty members at four top-rated liberal arts schools—Harvey Mudd College of Pomona, California; Wellesley College in Massachusetts; Hope College in Holland, Michigan; and Grinnell. The schools were among a group of 10 that NSF honored in 1998 for their success in integrating their twin responsibilities of research and education. They also help to stock the scientific pipeline: A greater percentage of undergraduates at Harvey Mudd—nearly half—go on to earn science Ph.D.s than at any other school in the country, for example.

The project, begun last summer, aims to identify key features of "good" research experiences, as well as create a survey instrument that other schools can use to measure their own efforts, says Lopatto. He suspects that "the benefits of undergraduate research will be related to a university's commitment." But the study isn't perfect, he admits. It lacks the usual control group, because "you can't go to a school and say we picked you because you're a failure" at providing research opportunities for undergraduates. And no follow-up is planned: Once the project ends in 2003, each school will have to track its own students if it wants longitudinal data.

Sheldon Wettag, provost of Harvey Mudd, says he expects the NSF study "to validate the importance of an undergraduate research experience," and he predicts that the results "won't change things much for us." A research-based "capstone experience" is a graduation requirement at Harvey Mudd, and Wettag says that the school has begun to encourage all students to become involved earlier in their undergraduate careers and to push sophomores into summer research projects. "We think that the sooner they get engaged, the more likely they will be to pursue science and to be more productive on their senior project," he says. Still, he acknowledges that "we haven't thought much about how to make [research] a good experience."

One of the few studies that has been done on the purpose of undergraduate research



Southern exposure. The lagoon at Discovery Bay, Jamaica, is an idyllic setting for students working at the nearby marine lab.

CREDITS: (TOP TO BOTTOM) MARK WILSON; JAMES ZENGHUANG/*CHINA FEATURES*

came up with mixed findings. A June 2000 report to NSF on its 15-year-old Research Experiences for Undergraduates (REU) program found a lack of consensus on goals and how to measure them. "It means different things to different people," says the principal author, Chip Story of SRI International, a research and consulting firm in Menlo Park, California. Visiting 12 of the more than 500 schools that had received NSF grants during the last decade to host students, Story found great variations in how the programs were carried out, who they served, and why institutions and students participated. At one site, Story says, students did no research at all; instead, they listened to speakers and planned visits to professional meetings and conferences. Many students see it as a way to bolster their résumés, he says, while some schools use it mainly as a recruiting device. At the same time, he noted that every school judged its program to be "successful" and that panels of outside NSF reviewers have repeatedly called for an expansion of the REU program.

Administrators at St. Mary's College of Maryland, a small state school in Southern Maryland, recently did their own cost-benefit analysis of the value of undergraduate research. In 1996 faculty members voted to require a research-based project of all seniors starting with the class of 2002 and began sponsoring them on a voluntary basis. But last year they changed their minds, modifying the rule to leave the choice up to individual departments. Ten chose to keep the requirement, including all the natural science programs, while 10 made it optional. "They didn't realize that it would take up so much time and be so difficult," says Lorraine Glidden, associate provost and a professor of psychology, explaining the vote, "or that some students would not be well prepared."

Even with an incentive—faculty members receive a one-course credit for every six projects that they supervise—many faculty members seem to view it as more of a burden than a benefit. Asked on a survey to rate its value to their professional development, faculty members gave the projects a 3.6 on a scale of 1 to 9. The mean score for all questions on the survey was 7.1. At the same time, students felt very positive about the experience, giving it a near-perfect 8.5 when asked how much they had learned. An internal evaluation concluded that "faculty assess it as a very positive experience for their students but mixed for themselves. They value the mentoring relationships but recognize that there is some trade-off in their own scholarship and creative work."

Doing the unexpected

Wilson has a much more positive view of his own experiences with undergraduate research. He says Wooster has prescribed an IS project for so long—since 1948—that the concept is ingrained in everything he does. "When I look at my research, I think first of how students can connect to it," says Wilson, who has published on evolutionary paleoecology in leading journals. "And when we are teaching, and students ask questions, the tag line is often, 'That would make a good IS project.' I think that people who wonder what a student can do are missing a big opportunity. They can do extraordinary things."

The IS project prepared him well for graduate school, says Wilson, who earned a Ph.D. in 1981 from the University of California, Berkeley. But he doesn't favor making it a requirement at all undergraduate institutions. "It's a huge investment in time and money," he says. "And faculty have to be active researchers for it to be of value. I think it would be very hard [for a school] to start from scratch if it didn't already value student research."

Martin's visit to Jamaica didn't change her career intentions, as she was already hooked on paleontology before she headed south. But it may have reinforced her choice. "It's my most favorite subject," she says. "The idea of seeing the past, and then trying to piece together how everything lived back then, is just incredible. It's what I want to do with my life."

–JEFFREY MERVIS

NEWS

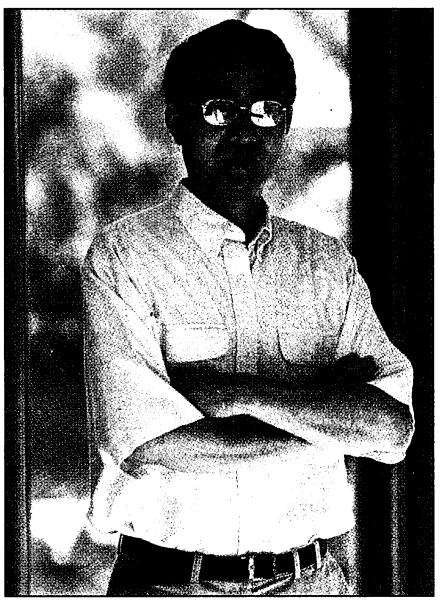
China Broadens Training For Elite Students

Beijing University is testing the idea of a Western-style liberal arts education on a select group of undergraduates. If it works, officials hope to give all students a chance to find their way before specializing

BEIJING—China's prestigious Beijing University will launch a pilot class next month to test the idea that a liberal arts education is more beneficial to students than a narrowly focused course of study. The radical approach runs counter to a half-century of specialization in Chinese higher education. If successful, it will be extended to all students—a giant step beyond concurrent reforms at some of the country's leading universities that focus only on the cream of the crop (see sidebar on p. 1616).

The pilot class at Beida, as the university is commonly known, is the latest attempt by university officials to reform a system imported from the Soviet Union in the 1950s. Based on a planned economy, the old system forced students to pick a major before taking the fiercely competitive college entrance examination, and it followed a well-defined curriculum with few, if any, electives. Upon graduation, students were then assigned jobs.

But that system is incompatible with modern China, says Zhu Qingzhi, vice director of the university's Office of Education Administration. The government can no longer provide job opportunities to all college graduates, he notes, and a market economy has given students more career options, including postgraduate studies in a field of their choice. "The pilot class project represents a new trend of the undergraduate education reform in China," he says. The new program is named



Trendsetter. Zhu Qingzhi leads undergraduate reform efforts at Beijing University.