David Lopatto

IMPACT FACTOR

ASK STUDENTS WHAT KEEPS THEM IN SCIENCE— THEY JUST MIGHT TELL YOU.

Mark Kegans

What draws students to science? David Lopatto aims to find out. Since joining the faculty at Grinnell College, this professor of psychology has designed surveys to learn how undergraduate students respond to summer and classroom research experiences. His findings reveal best practices for creating programs that sustain students' interest in science.

The number of undergraduate science students doing summer research has grown steadily for nearly 20 years. And from what their faculty mentors tell us, most of them are enjoying themselves as they are learning about the research process. But for me, these anecdotes aren't enough. I want to know how and why research experiences enhance education and attract students to science. What's more, how can we optimize these programs in ways that maximize learning and sustain a student's interest in a science career?

About 10 years ago, I began developing research tools to investigate these questions systematically. The tool I use now, developed in 2003 with HHMI support, is called the Summer Undergraduate Research Experiences (SURE) survey. This detailed questionnaire allows me to quantify student responses to a variety of topics, such as learning gains in specific areas, the impact of summer research on future academic plans, and the influence of mentors. During each of the last two years, more than 2,000 undergraduate students have responded, representing more than 60 colleges and universities.

In part, their answers validate what we knew already from anecdotal reports. Students in undergraduate research report that they learn how to do science, clarify their career plans, and are very satisfied with their experiences. More than 90 percent rate their experiences positively, and most claim they would have another research experience if they could.

I've also seen something unexpected in the data: the experience for so many students is defined more by personal development than by professional growth. Most students give high marks for professional factors, such as learning laboratory techniques and how to analyze data. But for those who report a successful undergraduate experience, attaining personal benchmarks—such as enhanced tolerance for obstacles, a readiness for more demanding research, and gaining a better understanding of how scientists really work—is particularly important.

When science educators ask about best practices for summer undergraduate research programs, I emphasize the need to promote personal as well as professional goals. Cumulative data from the SURE survey reveal specific measures that optimize student experiences. For instance, seminars given by visiting scientists help students clarify career paths; the more they hear professionals talk about themselves and what they do, the more they understand what a science career is really like. Ethics seminars are also important; students need to know about the broader implications of conducting research. Organized social activities, such as picnics and trips to the ball park, can help students feel like they're part of a learning community. Above all, mentoring by the research supervisor has the most dramatic effect on the student experience.

We've found that a good way to turn students off of science is to give them a bad mentor. But good mentors—who are supportive, aware of personal goals, and listen as much as they talk—can be a powerful factor in making the research experience a positive one.

Finally, we've found that students who close the experience with a poster session, a research paper, or some other final production hone key skills—such as science writing and oral presentation—that serve them well in the future. The take-home message is that a research experience isn't like a summer job. Whether these experiences are HHMI-funded or not, they involve continuous interaction between students, who learn to work and think independently, and a faculty member who provides structure and oversight.

A similar philosophy applies in the classroom. A related survey instrument—the Classroom Undergraduate Research Experience, or CURE—found that "research-like" classes produce response patterns similar to those seen with SURE. Successful research-like courses aren't organized around stock lectures and canned labs. Instead, they build learning around a shared research problem that students and instructors solve together. As with the best summer programs, these classroom experiences foster independence and teach research skills.

In short, the capacity to excel in science is tied closely to personal development. Students who make their own discoveries feel valuable in research, and that sense of worth generalizes across their character in many positive ways. We often hear that what this country needs in terms of science and technology is more innovation, invention, and transformation. If we want our students to advance those goals, then the research programs we design should encourage self-authorship, confidence, and creative thinking.

INTERVIEW BY CHARLES SCHMIDT. *David Lopatto is also a professor of natural science and mathematics at Grinnell College.*