meaningful undergraduate research experience offers students the chance to learn new skills, gain confidence, become more ambitious, and prepare for future careers (e.g., Elgren and Hensel 2006; Russell, Hancock, and McCullough 2007). No longer restricted to small colleges or honors programs, faculty-mentored undergraduate research or creative experience is increasingly featured among the goals and expectations of highly motivated students everywhere. Such experience is recognized as one of ten high-impact educational practices by the Liberal Education and America’s Promise (LEAP) initiative of the Association of American Colleges and Universities (Kuh 2008). Moreover, U.S. News and World Report now ranks colleges and universities based on reputation for providing opportunities that could lead to scholarly publications and presentations. At the national level, the Council on Undergraduate Research has been a strong advocate for high-quality undergraduate student-faculty collaborations.

At large, public, research-intensive universities such as ours, students now expect to have access to research opportunities. The student body is surrounded by well-funded faculty, postdoctoral fellows, graduate students, and others who have tremendous resources, expertise, and professional networks at their disposal. This sophisticated research enterprise provides a vast array of opportunities for students in all disciplines, and undergraduates are increasingly encouraged by faculty and advisers to take advantage of it. Although student-to-faculty ratios are high and professors are busy with grant-writing, research, teaching, and other professional duties, many faculty gain deep satisfaction from serving as research mentors to enthusiastic students. Working with motivated undergraduates also creates a pipeline to graduate programs and, once an initial training period is completed, may result in much-needed assistance with the faculty member’s research program. Funds to support student researchers may be included in grant requests from several national agencies and other sources. Some institutions also provide scholarships for student research projects and award funds to faculty supervisors as incentives for collaborative projects. However, in many cases, the current budget crisis has further strained budgets for enriching the curriculum.

CAMPUSWIDE UNDERGRADUATE RESEARCH OFFICES

To benefit from economies of scale, many universities have established centralized programs that coordinate and support undergraduate research and creative activities in all disciplines (see fig. 1). Central offices complement other efforts on campus that may be more departmental or disciplinary in focus. By coordinating efforts across campus and using Web-based resources, central offices can support a wide variety of initiatives that encourage the integration of research and learning. One of the most useful cost-saving products of a central office is a well-publicized and up-to-date Web site that provides a database of current research opportunities and information about why research experience is useful, how to get started on a research project, how to find funding, and how to present one’s results at meetings and in publications.
Many additional activities of a central undergraduate research office can be offered at low cost, funded collaboratively, or funded through external grants or gifts. In addition to one-on-one advising and coaching, a centralized undergraduate research office can offer group sessions—through workshops and seminars—that can reach students more efficiently. These sessions provide:

- inspiration for students to seek rewarding research experiences;
- assistance with identifying research opportunities and mentors;
- guidance on applying for funding through internal or external scholarships and awards or summer programs;
- instruction on becoming a professional, the ethical conduct of research, and understanding the research process.

Efficiency can also be gained by offering workshops and online resources to provide faculty with:

- guidance on successful mentoring practices;
- assistance with grant applications that include undergraduate research funds or supplements;
- strategies for recruiting and selecting students for specific research opportunities;
- support for including research experiences in courses or in designing cap-stone research experiences.

In addition, with modest internal or external funding, a central office can offer an annual undergraduate research forum or symposium, provide opportunities for students to publish their work in print or online journals, and introduce students to the review process by integrating them into this work as coplanners, editors, and reviewers. Taken together, all of these efforts raise students’ expectations of themselves as scholars, enrich their undergraduate education, and assist them in refining their longer term postgraduate education and career goals. A campuswide undergraduate research office can also work to increase recognition of faculty and academic units that have been successful in developing undergraduate research opportunities. While it is always easier to implement new activities with ample funding, we wish to describe how these efforts can continue to flourish in times of severe budget constraints. Below, we describe some specific examples of low-cost, high-impact strategies for fostering undergraduate research at our universities. Each of these ideas can be implemented for an entire campus or within specific colleges or departments. And although we focus on large universities, many of the approaches we have used may also apply to smaller institutions.

**MOBILIZING VOLUNTEERS**

Creating a community of student volunteers is an excellent way to get things done for free while providing students with service and leadership experience. Students who have already participated in research can inspire their peers and provide practical advice to help them get involved in research. And students’ perspectives and advice are essential for developing effective campus-wide programs that are appealing to undergraduates. At Ohio State, for example, the Undergraduate Research Office (URO) has a Student Advisory Committee, as well as a large group of student researchers who are available for peer advising. Student volunteers are happy to serve on discussion panels, help with events, and give presentations to student organizations and introductory courses. In 2009, URO volunteers reached more than 3,000 Ohio State undergraduates, including 23 percent of the freshman class, by giving short talks about opportunities for getting involved in research. Student volunteers help raise the profile of undergraduate research on campus, with little more than the occasional pizza dinner in return.

At the University of Washington (UW), graduate students and postdoctoral research associates also provide valuable volunteer service that benefits undergraduate research, while gaining important professional experience. For example, most of the more than 750 undergraduates who present their research at UW’s annual undergraduate research symposium attend a presentation practice session or a
workshop on writing a research abstract, creating a research poster, or making a PowerPoint presentation. Many of these workshops are delivered by postdoctoral associates or graduate students who are interested in gaining teaching experience for careers at primarily undergraduate institutions. In return for their service, Undergraduate Research Program (URP) staff provides letters of support, participant feedback on their presentations and teaching style, and advice on mentoring undergraduates under their direction. These volunteers provide a highly capable and willing workforce that greatly enhances what the URP staff could offer on its own.

A campuswide undergraduate research symposium can be an effective way to provide a forum for students to learn how to present their work, for undergraduates not yet involved in research to gain access to mentors and generate ideas for projects.

Purposeful undergraduates also generate new ideas and programs. A few years ago, a group of enterprising students approached Ohio State’s URO with a proposal to create a peer-reviewed, undergraduate research journal. The URO did not have the staff or resources to help them out, but it turned out that the students didn’t really need much assistance. Independently, and with the staff’s enthusiastic encouragement, they formed a student organization, developed an editorial board and editorial policies, created a Web site, and solicited manuscripts for an online publication. This year, JUROS (the Journal of Undergraduate Research at Ohio State) made its debut, complete with scholarly articles that are written and reviewed by students, feature stories, video profiles, and a faculty perspective. The journal can be viewed at www.jurosonline.com. The results were so impressive and professional that the URO decided to allocate funds for an inaugural hard-copy printing of highlights from JUROS.

COST-CUTTING AT THE ANNUAL UNDERGRADUATE RESEARCH SYMPOSIUM
A campuswide undergraduate research symposium can be an effective way to provide a forum for students to learn how to present their work, for undergraduates not yet involved in research to gain access to mentors and generate ideas for projects, for the university to showcase the pow-

- Replacing a printed booklet with fully searchable, online proceedings for the publication of student abstracts and related materials (www.exp.uw.edu/urp/symp)
- Reducing food costs. We used to provide lunch but now have just cookies and water coolers scattered throughout building
- Recognizing mentors by providing a forum for students to publish mentor appreciation comments, and presenting non-cash awards to outstanding faculty and graduate students
- Utilizing volunteers (students, alumni, staff, graduate students, and postdocs) rather than relying on paid staff for event set up, registration, guest reception, and the myriad tasks involved in running a large community event

CREATING A LOW-COST SUMMER RESEARCH INSTITUTE AND FALL POSTER FORUM
At Ohio State, hundreds of students remain on campus each summer to conduct research, whether paid or unpaid, in organized programs, or independently. About two-thirds of these students are funded by formal programs, each of which functions as an isolated group experience. To bring these disparate groups together and draw in free-floating students, we created a Summer Undergraduate Research Institute, with programs for professional development, brown-bag lunches, social events, Ultimate Frisbee, and softball. A paid undergraduate student leader helps coordinate the program, and the total costs amount to less than $6,000 per summer (255 students enrolled in 2009).

Summer researchers are strongly encouraged to present their work at a new, low-budget Fall Undergraduate Research Forum that complements our much larger, corporate-funded spring forum, which is now in its fifteenth year. The Fall Forum, with about seventy posters
and three hundred attendees, does not include judging or cash prizes. Students submit abstracts and discuss their posters with peers, faculty, and others, including OSU President Gordon Gee. This festive event recognizes their accomplishments and represents a major milestone in their professional development. Simultaneously, to inspire incoming students who attend the Fall Forum, we offer concurrent workshops targeted to freshmen and others who have not yet started doing research.

DEVELOPING INTEGRATED WEB DATABASE BUSINESS APPLICATIONS

The backbone of a successful, centralized undergraduate research program is the ability to manage data, and program information, and communicate with stakeholders effectively and efficiently. The Undergraduate Research Opportunities Program (UROP) at the University of California, Irvine, established in 1995, uses a Web database system to engage more than two thousand undergraduates annually. This homegrown system was developed in 2003 by a student who understood UROP-specific business needs and applications. It is used for many interrelated purposes—student interest forms; distributing information about research opportunities on and off campus; processing student proposals, applications, symposium abstracts, and journal submissions; supplementary documents; workshop RSVPs; nominations for student researcher of the month and faculty mentor of the month; publicizing news and events; and tracking expenses. A great advantage of integrating this information into a comprehensive database is the ability to produce instantaneous reports by department or individual faculty mentor listing students or projects supported by UROP since 1995, with links to students’ proposals, abstracts, or papers. These reports have proven to be a very effective way of recognizing faculty efforts and supporting their tenure and promotion cases, not to mention university accreditation reviews.

This Web-based system also allows us to initiate new programs within a short timeline. For example, UROP launched three new programs in summer 2005: the Integrated Micro/Nano Summer Undergraduate Research Program, in collaboration with the School of Engineering and funded by the National Science Foundation as a Research Experience for Undergraduates Site; Inter-Disciplinary Summer Undergraduate Research Experience, in collaboration with the School of Social Ecology and funded by the National Institutes of Health; and the Summer Undergraduate Research Fellowship in Information Technology, cosponsored with the California Institute for Information and Telecommunication Technology. With limited staffing resources, the Web database system has allowed the UROP team to reach far more stakeholders with much greater impact than was previously possible.

CONCLUSIONS: WORTH THE COSTS?

Investing in undergraduate research offers huge benefits that are not easily quantified because they are long term and multifaceted. In addition to providing life-changing educational experiences for students, undergraduate research enhances the university’s local reputation and national profile. College applicants and their parents are impressed when they learn about the many opportunities for students to work alongside graduate students and professors to address issues of global significance. Many studies have shown that students who participate in research are more satisfied with their education and more likely to complete their degrees than those who lack this experience (Nagda et al. 1998; Hathaway, Nagda, and Gregerman 2002; Russell Hancock, and McCullough 2007; Kuh 2008). Furthermore, whether they are doing research themselves or learning about it from peers, students benefit from understanding the essential links between research and learning. Quite often, the bonds that form between students and their faculty and graduate student mentors endure for years. Alumni who have taken advantage of research opportunities have good reason to give back to their alma mater later in life. Whether one’s institution is well-endowed or operating under great financial strain, supporting student researchers is a very meaningful and cost-effective way to enrich their education.

REFERENCES


