Undergraduate Research Experiences:
Synergies between Scholarship and Teaching

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For good reason, undergraduate student-faculty collaborative research opportunities are firmly embedded in the landscape of the New Academy. Undergraduate research and creative expression are now distinct categories of excellence in the *U.S. News & World Report* rankings. Collaborative research speaks to some of our most fundamental educational objectives by providing a personalized education, exemplifying engaged pedagogy, and promoting students' intellectual independence and maturation. Barrett Seaman's recent account of undergraduate residential life cites undergraduate research experiences as one of the ways that students make close personal connections with faculty mentors (2005).

These relationships are particularly important at a time when undergraduates are seemingly more disengaged in their education and rarely interact with faculty members outside of the classroom. These connections with faculty, across all academic disciplines and at a wide range of institutions, can be particularly meaningful to students deemed "at risk," including first-generation college students and minorities. For the past twenty-six years, the Council on Undergraduate Research has been a steady advocate and resource for institutions and faculty members seeking to implement research with undergraduates and create supportive environments in which these activities can flourish. Since 1989, Project Kaleidoscope has also brought together faculty and administrators to strengthen the learning and undergraduate research environments for mathematics and science.

Curricular and Institutional Transformation

We often cite the transformative effect research experiences can have on our undergraduate students, but the movement to provide more of these opportunities across all disciplines has led to significant transformations of curricula and institutions as well. Curricula that incorporate discovery-based and active learning have been designed to better prepare students for the independence required for a successful research experience (Karukstis and Elgren, forthcoming). Such curricular changes promote greater exposure to the primary literature; create opportunities to articulate and test hypotheses and intellectual models; and encourage students to contextualize and communicate objectives, approaches, analyses, and conclusions. These changes infuse research and research-like experiences into the curriculum.

Faculty members also stand to benefit from these curricular reforms. The curriculum is the purview of the faculty and should be a direct expression of what faculty value in education. It is also one of the ways that faculty gain some control over time, which many regularly cite as their primary limiting resource. Balancing a scholarly agenda with heavy teaching commitments easily consumes available time, but utilizing the curriculum to better prepare undergraduates for independent research serves them well and prepares them to contribute to faculty members' own scholarly work. Building synergy between these two activities has recently been referred to as an act of "enlightened self-interest" (Mills 2005).

Long-term, sustainable models that cultivate effective student-faculty collaborations take advantage of the natural synergistic relationship between two primary objectives: ensuring good student learning outcomes and advancing the research agenda of the faculty mentor. A third objective was raised at a recent National Science Foundation–funded summit on the state of undergraduate research in the chemical sciences, where participants suggested that effective undergraduate research should also lead to the generation of new knowledge. In this emerging model of effective goals for collaborative research with undergraduates, an ideal project should promote student learning outcomes, advance the research agenda of the faculty mentor, and make a new contribution to the field. When projects are crafted to carefully balance these three objectives, both research mentors and student collaborators benefit enormously from the experience (see figure 1). It is important to understand that this balance is uniquely negotiated for every student and every project. Unfortunately, campus-wide conversations regarding the balance of these three objectives can quickly become polarized between the teaching and research objectives and can subsequently turn contentious and unproductive. Care must be taken not to let these conversations move forward with inaccurate assumptions that might pit these objectives against each other.

Many institutions have reconfigured, renovated, and built new facilities to enable these pedagogical strategies to be fully implemented. These building initiatives have benefited enormously from the broad expertise and experiences brought together by Project Kaleidoscope at their popular "Building Spaces for the Sciences that Make a Difference" workshops. Institution teams participating in these workshops are required to have faculty and administrative representation. This makeup promotes transparency in how these projects are conceived and executed.

Expanding Participation

Introducing research opportunities where they do not currently exist can be challenging and seem daunting. Enthusiasts attempting to introduce these activities often face skeptics who claim such activity slows scholarly output and that capacity, facilities, resources, and administrative support are limited. However, many institutions have successfully cultivated undergraduate research participation across the full spectrum of academic disciplines. Princeton University, the College of Wooster, and other institutions have long-standing graduation requirements for *all* students requiring a capstone research experience. In addition to substantial annual support for summer science student stipends, Hamilton College has raised endowed funds to support twenty fellowships each summer "in areas where funding is not readily available" (www.hamilton.edu/undergraduateresearch). While many Hamilton colleagues outside the sciences were originally skeptical and reluctant to participate, these stipends are now oversubscribed and competitive. In fact, nearly every department has had a faculty member submit a proposal. Many have come to realize that they can craft a project that allows students to contribute in meaningful ways to advancing their own scholarly objectives. Students at several campuses have also recognized the value of undergraduate research to the extent that the student government has voted to assess additional fees to support student and faculty stipends for research; such support is a powerful testimony to the benefits of undergraduate research.

Return on Investment

Recognizing the impact of undergraduate research on student learning, student and faculty retention, and institutional reputation has led many institutions to respond with extraordinary support for undergraduate research. Colleges and universities have allocated and sometimes raised funds for student (and faculty) stipends, provided sabbatical leave programs to ensure continued scholarly development for faculty members, reduced teaching loads, rewarded research mentoring activities with teaching credit, provided generous start-up packages for new faculty members, matched funds from external grants, and increased technical support for routine departmental tasks. New buildings have been designed and erected on some campuses to expand opportunities for undergraduate research.

Clearly, many of these expenditures are required to attract and retain the most competitive students and faculty members. Less clear are the returns that institutions

expect from these investments. Faculty members welcome institutional support for research and teaching, but such support also raises concerns about changing expectations for faculty and students. Concerns may vary depending on the institutional mission and culture. Faculty members who teach at primarily undergraduate institutions wonder if the increased emphasis on research and the potential for increased external funding may lead to a decreased emphasis on teaching and time spent with students in out-of-class activities. Many of these professors chose small liberal arts colleges precisely because they enjoy teaching and mentoring undergraduate students. Other professors worry that increased expectations for undergraduate research may cut into the time available for their own research interests. Increased expectations for publications and external funding can be a source of anxiety for professors who did not begin their careers expecting to engage in research and the quest for external funding; this may be especially true for disciplines other than science. Attention to the connections between effective teaching, supportive mentoring, and appropriate research expectations is critical for maintaining a strong and vibrant academic culture on campus.

Success Begets Success

A variety of successful undergraduate research models can be found on American campuses with programs that reflect their institution's unique characteristics and geographical area. In addition to the successes described elsewhere in this issue of *Peer Review*, it is worth describing several others that exemplify the variety of institutions and disciplines involved.

The University of Nebraska-Kearney, for example, began a multidisciplinary research project four years ago with a grant from the National Council on Undergraduate Research/Lancy program. The grant supported a dozen students from different departments who worked with a mentor to design and conduct research or creative work over the summer. When the term of the award ended, the institution continued the program, now known as the Summer Student Research Program (webcms.unk.edu/acad/gradstudies/ssrp). The original summer program focused on environmental, political, and cultural studies of the nearby Platte River area of Nebraska. It is a particularly appealing project to University of Nebraska–Kearney students, since many are native Nebraskans. An English major funded through the project reconsidered a mid-century study of Nebraska dialects. She found that while the regional variances in the lexicon still exist, a new geographic pattern has emerged that divides the state by proximity to the Platte River Valley and Interstate 80, suggesting that immigration from other states has affected language. A history student explored the common and unique characteristics of small Nebraska towns that are losing population or have disappeared. Such information is relevant to local economic development efforts. The University of Nebraska–Kearney has developed a research program that capitalizes on its geographic location and, in

Figure 1. Clarifying undergraduate research objectives

- *Student learning outcomes* comprise the myriad ways in which students benefit from being involved in hands-on, primary research projects in collaboration with a faculty mentor. Inviting students to invest intellectually in a project gives them the opportunity to help shape its direction, exert some of their own creativity, and experience the joy of intellectual "ownership" of the products resulting from the effort.
- *Continued development of the faculty mentor's scholarly agenda* acknowledges the essential role that an active, productive research agenda plays in the ability of the faculty mentor to provide meaningful research experiences for undergraduates and advance professionally. Furthermore, without clear contributions to the faculty mentor's scholarly interests, he or she is likely to begin viewing these mentoring activities as primarily a teaching obligation, as opposed to one of the ways in which the institution continues to support his or her professional development.
- *Making a new contribution to the field* sets a high standard for the work we value. For most disciplines, publications remain the "coin of the realm." A steady record of bringing projects to fruition (i.e., publication) is essential for a research agenda to attract external funding. Other forms of dissemination are also important for the visibility and professional development of both the faculty mentor and student collaborator. For example, dedicated sessions for undergraduate student presentations are now included in the programs for many professional societies. The National Conference on Undergraduate Research (NCUR) has been a popular venue for undergraduates from all fields to present their research results since 1987. In another example of reporting research results, students from Wheaton College in Massachusetts regularly report the results of their water-quality research to the local water board, town conservation coordinators, and state Environmental Protection Agency officials. The Wheaton program represents a unique form of dissemination that ties nicely into their effort to promote civic engagement in the curriculum.

doing so, also contributes to the vitality of their region.

Other institutions are just beginning to develop an undergraduate research program, and often the development of the program is dependent upon the interest and enthusiasm of an individual faculty member or department. The University of Maine at Presque Isle, a small, public liberal arts college in the most northern part of Maine, is an example of an institution in the beginning phases of undergraduate research. A majority of the students are first-generation college students, many of whom have not traveled far from their small, rural hometowns. For such students, an undergraduate research experience can be a significant affirmation of their ability to do quality academic work. The English department at Presque Isle has designed several of its upper-division courses to encourage students not only to write critical essays and research papers, but also to write papers that might be presented at national conferences. Several students each year have successfully presented at national conferences and published their work. In this way, the curriculum is now building momentum around scholarly research activities.

Institutions are also conducting global undergraduate research projects. The McMaster School for Advancing Humanity at Defiance College (www.defiance.edu/pages/MS_description.html) sends student and faculty teams to work in Belize, Nicaragua, Guatemala, Cambodia, and several other countries. The projects span the disciplines and professional programs of the college. This winter, for example, a student and faculty mentor will be working in Cambodia to study and preserve the mythology, fairy tales, and personal stories of the Khymer people. Following the genocide in that country, Cambodia has few resources to devote to cultural restoration. Environmental monitoring, soil analysis, domestic violence, teacher preparation, illiteracy, and technology assessment are some of the other areas student-faculty teams will be studying.

Indicators of a Successful Program

Success can be demonstrated in many ways. Some consider broad participation of both students and faculty as a primary indicator of a strong program. Others consider this to be the starting point and assess quality in terms of the numbers of students going on to do graduate work in the discipline, students coauthoring publications and making presentations, and faculty-raised external grants. Conversations that clarify objectives and external metrics used to assess success can be very productive at the departmental, divisional, and institutional level. Such conversations can increase transparency and build broad understanding of the individual and institutional commitments made to implement and sustain undergraduate research programs. Institutions continue to promote and cultivate these activities because the student learning environment benefits enormously when there is synergy between a faculty member's research and the teaching mission of the institution. ■

References

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Leading Undergraduate Research Organizations

The Council on Undergraduate Research and its affiliated colleges, universities, and individuals share a focus on providing undergraduate research opportunities for faculty and students at predominantly undergraduate institutions.
www.cur.org

Project Kaleidoscope is an informal national alliance working to build strong learning environments for undergraduate students in mathematics, engineering, and the various fields of science, with an emphasis on what works.
www.pkal.org

The National Conference on Undergraduate Research promotes undergraduate research scholarship and creative activity done in partnership with faculty or other mentors as a vital component of higher education.
www.ncur.org