Students as Change Agents

Also in this issue

Undergraduate Researchers Change Learning and Teaching: A Case Study in Australia and the UK

A Circular Model for Framing the Undergraduate Research Experience
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The Council on Undergraduate Research Quarterly and CURQ on the Web serve as the official public “voice” of CUR to both its members and to a broader community. Their purpose is to provide useful and inspiring information about student-faculty collaborative research and scholarship from all disciplines at all types of institutions. The goal and function is to advance the mission of CUR. To this end, the operation and editorial policies are flexible so that its content and deadlines meet the immediate needs of the communities that it serves. The CURQ on the Web can be found at www.cur.org/publications/curquarterly/.

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Cover Photo: Roxanne Krutsinger, undergraduate at Southern Illinois University Edwardsville and industry collaborator Vic Jost of Jost Greenhouses place cuttings in a research project on the Student Success Center Green Roof.
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www.cur.org
As I began to pack up my office contents to move them to my new job as associate provost for experiential education at Florida Southern College, I’ve taken some time to thumb through older issues of the CUR Quarterly—specifically those published in the late 1980’s and early 1990’s when the publication was known as the CUR Newsletter. There were many articles focused on the importance of supporting students so that they “move from being passive test takers to active participants” (Morig 1989); benefit from “intellectual cross-fertilization” that results from presenting their work at a meeting (Mills 1988); and receive “financial support” (Shinn and Maxwell 1988 and Harward 1990). As one skims CURQ issues as they progress through the years, articles shift from one theme to another, but what remains markedly consistent is the care, interest, and devotion displayed for creating the best possible research experiences/learning environment for undergraduate students. More recent issues are helping to document how transformative the experience can be for students with respect to learning outcomes, persistence, and a gateway to graduate study (CURQ Spring 2009 and Spring 2012).

What has been largely missing from the CUR Newsletter and CUR Quarterly, however, is the impact that our undergraduate researchers have had on us, our research programs, and on our institutions. I think we have trouble identifying how individual students have impacted our lives, but I know that, collectively, my undergraduate researchers have taught me patience, the importance of paying attention to detail, and that students’ avoidance of a task or procedure usually means a lack of confidence in their own abilities.

I believe many of us would agree that a simple question posed by a novice researcher not bound by disciplinary assumptions can change the direction of our research programs. An undergraduate researcher’s project that “tinkers around the edge” can spur us to step over disciplinary.
boundaries and help us build relationships with unlikely partners.

Should we be surprised, then, that our students can be change agents on our campuses in the realm of the support and growth of undergraduate research? Each year students at the University of Wisconsin LaCrosse vote to devote a substantial percentage of their student fees to support undergraduate research. Numerous campuses have had students create “undergraduate research student groups” that participate in student governance and garner funding from student affairs for travel to disseminate results of their work. Many campuses (and individual research faculty) have undergraduate researchers serve as peer mentors in their undergraduate research programs, with upper-division students mentoring newer students. This model has been used and perfected by many of the Ronald E. McNair Post-baccalaureate Programs.

Students were the impetus for the founding of research journals devoted to undergraduate students, such as the State of North Carolina’s Explorations. Students have also pushed for NCUR to adhere to sustainability initiatives on host campuses. Lastly, I have talked with students from two different campuses who have funding from the Howard Hughes Medical Institute’s Science Education Program (http://www.hhmi.org/grants/sea/index.html). Students on these campuses are using their collective voices to encourage faculty to make all of their biology courses research-based. Let us not discount students’ social media savvy: They take to Twitter, Google+ and Facebook to share, inform, and shape the future of undergraduate research.

In the end, we should embrace, empower, and engage our students to push for institutional reform and support of undergraduate research. I believe Boyer (1990) stated it best: Institutions need to build “a purposeful community, where faculty and students share academic goals and work together to strengthen teaching and learning.”

Mary Crowe
Associate Provost of Experiential Education
Florida Southern College
CUR President

References
Change is a powerful word that can evoke mingled terror and delight. When used in the context of learning theory, change in the breadth and depth of student learning is characterized in Bloom’s taxonomy of learning domains as a series of plateaus that majestically and mysteriously progress from low to high levels of learning proficiency. We know that the process by which students transition from the more simplistic learning modalities such as memorization to the ability to create new knowledge is neither linear nor predictable. Autodidacts are seemingly few and far between, yet the need for modern societies to grow more of them is pressing as the pace of innovation and change in the global economy and workplace accelerates. Mastery of the ability to learn how to learn, to become a highly proficient self-directed learner, is a core goal for many of us who are faculty and administrators. Yet how do we grow and maintain our ability in this regard?

The articles in this issue all address changes in undergraduate student learning and provide a series of compelling—and sometimes surprising—accounts of rapid ascents in self-directed learning proficiency, mostly through research programs developed by students themselves. Several of the articles point out that students empowered by this type of instructional process often expand the scope of these research programs to change their educational institutions. There is a fierceness and pride to these students.

At the CUR Conference this past June at The College of New Jersey, over 500 faculty and administrators from more than 200 diverse educational institutions, associations, and funding agencies and foundations convened to learn from their colleagues, share experiences, and network professionally. The theme of the conference, “Leveraging Uncertainty: Toward a New Generation of Undergraduate Research,” had as its four subthemes (1) research transcending historic disciplinary boundaries; (2) sustaining undergraduate research in an era of fiscal uncertainty; (3) online technology in undergraduate research—possibilities, threats, and challenges; and (4) the challenges and opportunities of undergraduate research in a broad global context.

Inherent in these four subthemes is the notion of change, of transition, into a largely unknown future beset with both great challenges and opportunities. The professionalism of the presenters, the richness of the conversations in the sessions, the energy that infused the gathering, as well as the magnificent hospitality of The College of New Jersey’s administration and faculty, were all factors in the great success of the meeting. This was truly a great environment for high levels of creative, self-directed learning and a showcase for many “agents of change.”

Immediately before the CUR Conference, CUR held its annual business meeting, at which the CUR Councilors discussed six strategic foci for CUR (as an organization) to consider for the next three- to five-year period. These foci were derived from past input from CUR’s governance bodies, various CUR members, faculty attending various CUR Institutes, and past CUR strategic planning exercises. They include: (1) broadening and diversifying undergraduate research, (2) assessment of undergraduate research, (3) embedding undergraduate research in the curriculum, (4) internationalization of undergraduate research, (5) linking undergraduate research with innovation and entrepreneurship, and (6) CUR governance changes. Rather than serve as a constraint on CUR’s historically fluid and rapid development, these six domains amplify and connect existing emphases within the organization, and they align with many of the themes of change and evolution that are currently discussed in higher-education circles. Based on the robust and energized discussions that took place in New Jersey, led by CUR President Mary Crowe and immediate past-President Bill Campbell, CUR’s members are in the forefront of thoughtful leadership in these domains, including how these themes can connect with the disciplinary emphases within individual CUR divisions, with CUR members’ home institutions, and with the interests of the broad array of stakeholders and partners with which CUR engages. Again, the message is that CUR is a learning organization, strong and proud.

As we are now facing another historic presidential election, the theme of transition again resonates throughout the Capital. In the midst of partisan interactions, CUR’s mission and its Washington-based events continue to be very
well-received and well-attended. We will be holding CUR Dialogues in February 2013 in Washington, and registration is now open on the CUR website (http://www.cur.org). The April 2012 Posters on the Hill (POH) event drew a record 850 applicants, and the 82 posters that were presented on April 24 were attended by more than a dozen legislators and many of their staff members, as well as hundreds of other participants. Students frequently remarked on how much positive, one-on-one attention they received from legislators and the keen interest displayed in their research work by the legislators and their staff members. We expect that the 2013 POH will be another stellar CUR event featuring excellent undergraduate student researchers, who, like those described in this issue of the CUR Quarterly, figure strongly as agents of change in their own learning, their institutions, and CUR. That they have the power to impress decision makers in Washington is also remarkable—and testimony to the significance of undergraduate research.

Elizabeth Ambos
Executive Officer
Undergraduate Researchers Change Their Institutions

Many of us have been amazed at seeing what students are able to accomplish in their undergraduate research projects. That amazement, and the pride that we felt knowing we had aided their accomplishments, often has kept us going when we have had too many things to do and perhaps haven’t been compensated or recognized for what we have contributed to their efforts.

In this issue of the \textit{CUR Quarterly} we celebrate some of the ways that students’ undergraduate research projects have impacted their institutions. As mentors of undergraduate researchers, we strive to give students a full and authentic research experience by allowing/requiring/encouraging them to present and publish their work, thus contributing to their disciplines. Some projects, though, either by design or by chance, wind up making a different kind of contribution. In this issue of the \textit{Quarterly} we provide a sampling of the many ways that UR projects have led to institutional change.

Margaret Anderson, a student at Roanoke College, worked with the institutional assessment office on campus to conduct a content analysis of the reflective essays required of undergraduate Summer Scholars there. Following the analysis and a literature search on the practice of reflective essays, she proposed a new structure for these reflections that has not only been implemented for the Summer Scholars program, but also for other experiential learning opportunities such as internships, study abroad, and service learning. This new practice has, in turn, helped the undergraduate research office identify areas in its programs needing improvement. Similarly, at Capital University, psychology professors Andrea Karkowski and Jody Fournier have mentored a series of undergraduate research projects that have helped the institution collect and analyze assessment data and address areas of institutional concern. This has helped faculty members to juggle the competing demands on their time, while having a significant impact on institutional practice.

At State Fair Community College in Sedalia, Missouri, a student interested in replicating a 1953 experiment inspired faculty members to engage in a long-lasting, cross-disciplinary collaboration focused on integrating student-initiated research projects into the undergraduate science curriculum. Over the course of three years, the curricula of biology and chemistry courses for both science and non-science majors were modified to place less of a priority on content knowledge and more of an emphasis on the real-world, collaborative effort of scientific investigation.

In the School of Natural Sciences and Mathematics at Ferrum College, Michaela Gazdik and Jason Powell have encouraged a student-directed research model that has affected faculty research by encouraging faculty to pursue questions that may not be as deep and narrow as those they pursued in their graduate research, but that are considerably more accessible to students and feasible to carry out at a small institution with limited resources.

At Southern Illinois University Edwardsville, a substantial number of undergraduate research projects have focused on environmental sustainability. These projects have been conducted in a variety of disciplines, including biology, chemistry, engineering, construction, curriculum and instruction, geography, psychology, and sociology. Some of these projects have been designed to provide concrete solutions to defined sustainability issues on campus. These have led to the creation of, for example, multiple “green” roofs on campus that, in turn, have led to a plethora of projects focused on understanding and analyzing a variety of questions about the functioning and impact of such roofs.

Two articles about students as change agents can also be found in this issue of \textit{CURQ on the web}. Padmanabhan Seshaiyer at George Mason University has found that exposing students to advanced topics in mathematical sciences that have applications to the real world has helped transform the practices of teaching, research, and education there. Laurie McMillan at Marywood University has found that informal research on local issues provides an opportunity for students to be exposed to research, learn research methods, and have an impact on the community.

Many of the articles in this issue contain ideas for research projects that can easily be carried out in a variety of institutional settings at relatively low cost. In these economic times, surely we can all use a few ideas like that.

Janet E. Stocks
Baldwin Wallace University
CURQ Issue Editor
Mission
The Council on Undergraduate Research Quarterly serves as the official public “voice” of CUR to both its members and to a broader community. Its purpose is to provide useful and inspiring information about student-faculty collaborative research and scholarship from all types of institutions.

Aim and Scope
The CUR Quarterly and the CURQ on the Web are quarterly international peer reviewed publications of the finest research in the undergraduate research community covering all disciplines and institutional types. The CURQ on the Web highlights pieces specific in nature, whether it be by audience or discipline, while the print CUR Quarterly is aimed at a more general audience both provide insightful studies, news, and examples. The CUR Quarterly has a readership of over 8,000.

In each issue of the CUR Quarterly and the CURQ on the Web contain articles that inform our understanding of the undergraduate research enterprise, including descriptions of examples of effective practice; practical advice for faculty, institutions, and other advocates for undergraduate research; and research on undergraduate research program outcomes. In each issue, some of these articles explore aspects of a common theme, while other articles report on important innovations and outcomes in the undergraduate research arena. All articles, including those connected to themes, undergo full peer review.

History
1980 The first CUR Newsletter is printed
1993 The CUR Newsletter becomes the CUR Quarterly
2002 New feature developed for the CUR Quarterly: “Undergraduate Research Highlights”
2005 Started quarterly solicitation of proposals for theme articles
2008 First issue of CURQ on the Web published
- A professional copy editor added to the CUR Quarterly team.
- The peer-review process instituted.
2009 New feature developed for the CUR Quarterly: “CURQ Vignettes”
2010 New feature developed for the CUR Quarterly: “From the International Desk”
- The CUR Quarterly now distributed electronically
2011 New feature developed for the CUR Quarterly: “Book Reviews”
2012 CUR Quarterly and CURQ on the Web submissions and review process moved to manuscript management software

Meet the CUR Quarterly and the CURQ on the Web

Staff and Editorial Board
11 divisional editors, 4 features editors, 2 issue editors, a technical editor, a copy editor and an editor-in-chief compose the CUR Quarterly and the CURQ on the Web team.

How to Access
The CUR Quarterly is sent to individual members and institutional member representatives and all members; anyone at an institution with enhanced membership can gain access to view each issue online. The library at each institution with a membership also receives a hard copy to make available to the campus community. Key articles from each issue are made available for all to access on the CUR Web site. Subscriptions are also available for individuals or libraries.

The CURQ on the Web is accessible to all on the CUR Web site. In addition to being accessible on the CUR Web site (www.cur.org), the CUR Quarterly can also be accessed through EBSCO Host (2008-current) and Gale Group (2010-current). Be sure to search the full title: Council on Undergraduate Research Quarterly

How to Submit
The CUR Quarterly team is excited to announce that starting in the fall of 2012, we will be accepting articles through a manuscript management software system.

To submit a manuscript you will need to visit http://curq.msubmit.net. For further details on the submission process, please see the inside back cover of this issue.
One of the fundamental purposes of encouraging undergraduate research is to empower students. Margaret Anderson, a rising senior majoring in political science at Roanoke College, examined the effect of structure on the quality of the reflective essays required of participants in the college’s Summer Scholars Program. The Summer Scholars Program is a grant program that allows undergraduates to conduct independent research with a faculty mentor over the summer. Her recommendations for structured reflection have become an essential component of Roanoke College’s new Pathways Program, which is focused on increasing the quality of experiential learning experiences in five areas: undergraduate research, internships, study away, service learning, and artistic/creative works.

As we implement the Pathways Program, students involved in each of the experiential learning programs will use the new reflection process, and Roanoke College will benefit from gaining authentic assessment data. The implications for research findings from undergraduate research can go beyond a specific discipline and individual students’ development; the research findings can have an impact on institutional decision-making. Below, Margaret describes her research experience studying the impact of a summer research experience on undergraduate students. Then we offer recommendations for using undergraduate researchers to conduct research on undergraduate research programs.

Undergraduate Research on UR Leads to College-Wide Change

An Undergraduate Researcher’s Perspective

Following is Margaret Anderson’s description of her own study of student researchers’ assessments of their summer research experiences:

I am an undergraduate student. I have no degree, and I do not specialize in anything prestigious. I am not a doctor, lawyer, judge, teacher, or engineer—yet I have been an instrument for significant change at Roanoke College. I have been able to influence how students think and reflect upon their experiences after participating in an undergraduate research program—specifically Roanoke College’s Summer Scholars program.

I started this project as a second-semester freshman. Dr. Filer, the director of institutional effectiveness and assessment, asked me to read and code the content of the reflection papers from our Summer Scholars students. To her knowledge, no one had systematically analyzed these essays beyond a cursory reading by the director of student-faculty research. Dr. Filer was curious what students learned from their summer research experience, and I was interested in learning and applying qualitative research skills.

I used a qualitative cluster analysis to identify the main themes in Summer Scholars’ reflection essays from 2009 and 2010 (Taylor-Powell and Renner 2003). In doing so, I hoped to discover student outcomes from a summer research experience. Many students, however, did not have substantial responses. Even though themes such as “growth” and “positive experience” were found, students did not identify the specific experience that led to growth or what program elements led to a positive experience. This is problematic because student reflection helps us to understand the connection between the experience and student learning. Specifics are also crucial to inform necessary changes to further enhance the program.

After a thorough review of the literature on reflection, I recommended that Roanoke College implement the DEAL model of critical reflection for the Summer Scholars reflection paper (Ash and Clayton 2009). This model focuses on three major steps:
1) description of experiences in an objective and detailed manner to create meaning; 2) examination of those experiences in light of specific learning goals or objectives; and, 3) articulation of learning, including goals for future action that can be taken into the next experience for improved practice and further refinement of learning.

Apparently, my advice came at an auspicious time. Dr. Filer and others at Roanoke College were in the middle of developing a Quality Enhancement Program proposal as part of their regional reaccreditation process. The QEP development committee was looking for strategies to incorporate reflection into their learning model (plan, reflect, showcase) for experiential learning. They adopted the DEAL model for all experiential learning programs, not just Summer Scholars. In fact, in the year prior to implementation of the Pathways Program, Roanoke College required the DEAL model of critical reflection for all Summer Scholars students, all Undergraduate Research Assistant Program (URAP) students, and all work-study research assistants.

With the adoption of the DEAL model, we are already seeing more substantive reflection. Student Summer Scholars’ reflections now include references to specific learning experiences, including references to what was learned, how it was learned, and who made it possible. Students now reflect upon specific experiences and examine them from a personal, civic, and academic perspective (Ash & Clayton 2009). We will continue to code the content of these essays, strive to understand what students learn from research (and other experiential learning opportunities), and determine how the college can continuously improve these programs. I am proud that I have changed the quality of student work in addition to the reflection process itself.

Looking back on this experience (which began the second semester of my freshman year), I am thrilled to observe the results of my qualitative study’s ‘simple coding.’ Even though I knew that analyzing Summer Scholar reflection essays was going to help someone, I had no idea who or when my coding was going to become significant—if ever. Now I realize how imperative research can be and how complex it can be to create results that will be respected and useful. Moreover, the effort that I put into this research project has not only been able to assist Roanoke College in improving its reflection and assessment processes, but has also greatly assisted me personally. I have grown from this experience in ways that I never thought I would when I walked onto Roanoke College’s campus.

Now I know how to write an effective analysis of research results; present my results at multiple conferences (Anderson, Filer, & Lyon 2011a, Anderson, Filer, & Lyon 2011b; Lyon et al. 2011); verbalize my results to professionals at other institutions; and observe the implementation of research ideas. None of this would have been possible, however, had it not been for the support and trust of two Roanoke College administrators who decided to take a leap of faith and ask for the assistance of an undergraduate.

Even though it is not necessarily the norm for an undergraduate student to assist with institutional assessment, it is possible and can be effective. Not only did I develop skills in conducting qualitative research, but I also was able to institute what I hope will be lasting change at Roanoke College. I found many skills that I did not realize I possessed, such as: time management, an understanding of qualitative analysis, and the ability to concisely record my results and recommendations. Overall, I hope that my research illustrates that undergraduates can be a unit for change, can improve curricula, can find solutions to institutional issues, and can make a difference in the world of research (no matter the field). We simply have to be given the opportunity to do so.
Administrators’ Points of View

Margaret’s experience shows that undergraduate research on undergraduate research is possible and can influence college-wide programs. Roanoke College received several benefits from having Margaret code the Summer Scholars essays. First, she developed qualitative research skills, which will be helpful as she applies for and attends graduate school. Second, the institution benefited from her research project in the form of improved UR programs and enhanced college-wide experiential learning programs. Not only have student reflections become more substantive based on her suggested changes, but we also are learning more about what the essential factors are that contribute to a good undergraduate research experience at our institution.

The reflections in the 2009 and 2010 Summer Scholars’ essays also were used in conjunction with an end-of-summer survey of the Summer Scholars to implement the following program improvements:

- Reorganization of our colloquium series
- A renewed focus on faculty mentor accessibility to students
- Housing for scholars in apartment-style, on-campus facilities

Now that we have used the DEAL model for the 2011 Summer Scholars, we have asked another student in our research group (Jennifer Blaney) to code the latest reflective essays. Jennifer has been able to pinpoint the specific experiences that lead to a positive or negative experience for our Summer Scholars. For example, several students experienced frustration and setbacks in their projects. However, key to Summer Scholars’ feelings that they had an excellent experience was that the faculty mentor helped them to see that failure is part of learning and that persistence matters most.

From a science student’s reflective paper:

My goals from having continued failure with research were to stay strong, keep trying, and to find a solution. At first, I was crushed and upset that my research was failing, but I was glad that [my faculty mentor] understood I was really trying. I was surprised that research was going this way because I had [been successful] during the school year. I understood what to do and how it worked, so I was a little stumped as to why things would not work. I learned that research is not easy sometimes, but it is important to stay positive. I learned it is important to keep trying because the same thing in my research kept failing, and my research problem would not have been resolved if I quit.

Surveys suggested that students are frustrated when their research does not “work,” but the reflective essays identified how the student reaction and interpretation of the experience created important future lessons. From a program perspective, we believe incoming Summer Scholars should know that they are not alone in experiencing frustration at some point in the process. For the 2012 season, we are implementing a student panel of 2011 Summer Scholars who will give advice to the 2012 Summer Scholars.

We also made some additional changes to the application process, both for students and for faculty, based on the results of the 2011 essays. Specifically, those few students who had negative experiences with Summer Scholars pointed to lack of mentors’ availability, engagement, and interest in the project. As these are student-driven projects, the application process required the most effort from the student, with faculty mentors required only to write a short letter of recommendation indicating they would be willing to guide the project. For 2012, our goal is for every Summer Scholar to have an outstanding experience. To that end, we have implemented a two-part application process, with faculty mentors required to apply as well. Many of the new requirements are based on best practices from other colleges and universities, such as Elon University’s Summer Undergraduate Research Experience (SURE 2012). Our plan is to continue to use the reflective essays not only as a tool for student learning but also as an assessment instrument to continually improve our programs.

Undergraduates in Institutional Research

Our success with Margaret has shown that we can, and should, involve undergraduates in campus-wide assessment projects. Student projects using institutional data can help us deepen our knowledge of program effectiveness, directing our decisions about how programs should change and how we can continuously improve. In fact, we have been strategically using undergraduate researchers to collect and analyze data for many of the college’s programs. For example, our team of research students has designed and conducted studies, analyzed data, and provided recommendations for projects including:

- Focus groups of business students (to improve the business administration major and concentrations)
- Focus groups of honors students (to provide the student perspective on honors program improvements)
- Focus groups of a cross-section of students (to provide input into the Quality Enhancement Program)
• Surveys of freshmen in residence halls (to assess whether alcohol-education programs impact student binge drinking)

• Longitudinal data analysis of senior exit surveys (to determine factors that significantly predict student satisfaction)

Undergraduate participation in assessment activities is not only seen at Roanoke College; it is documented by the New England Consortium on Assessment and Student Learning (NECASL). This consortium, comprised of seven selective liberal arts colleges in New England, is “exploring how students learn and how they make important decisions about their academic programs” (New England Consortium on Assessment and Student Learning 2011). For the NECASL project, students were trained to conduct qualitative research, specifically student interviews. The consortium found student researchers developed research skills and opportunities for later research projects, while the project gained information from student interviews that may not have been accessible to faculty interviewers (Bates, Droste, Cuba & Swingle 2008).

Additionally, CUR affiliates have argued that more students should be involved in mentored research opportunities, both in and out of the classroom (Boyd and Wesemann 2009; Karukstis and Elgren 2007; Mateja 2011). Involving undergraduates in institutional research expands the pool of available projects. Students engage in applied research in an authentic work environment.

### Developing Undergraduates’ Research Skills

In their work on Roanoke’s institutional assessment projects, the undergraduate researchers have demonstrated the following knowledge, skills, and abilities:

- conducting literature reviews
- writing survey items
- developing focus group protocols
- entering and coding qualitative data
- summarizing research findings into nuggets appropriate for administrative audiences
- giving oral presentations
- learning what it means to be part of a motivated team
- learning how to efficiently meet deadlines
- learning how to collaborate
- learning how to juggle multiple responsibilities

We believe undergraduates possess unique insights that help us to understand the results of our campus data. Further, students are excited to learn these skills and know that their suggestions improve the campus that they care deeply about. Throughout this process, we were pleasantly surprised at the high quality of work undergraduates produced with relatively low levels of administrative oversight. For colleges interested in engaging undergraduates in institutional research, we advise the following:

- Assume that undergraduates are qualified to do this type of research.
- Pitch the research as a resume-building opportunity.
- Appeal to the students’ pride in their institution (since much of this research directly benefits the college or university).

Beginning with the contribution of one strong freshman and continuing with a cohort of undergraduate researchers conducting institutional assessments, not only did Roanoke College improve the quality of one of its research programs; it also gained the valuable insight into the role undergraduates can play in institutional decision-making.
References


Margaret A. Anderson

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Margaret A. Anderson is a senior political science major at Roanoke College and a member of Phi Beta Kappa and Omicron Delta Kappa. As a student researcher in the Undergraduate Research Apprentice Program, she has developed her social-science research skills and presented at regional and national conferences. Currently, she is co-authoring a book about Virginia’s death penalty with Dr. Todd C. Peppers.

Kimberly Filer, PhD is the director of institutional effectiveness and assessment at Roanoke College. Filer works with academic department and program leaders as well as administrative department directors in developing, maintaining, and conducting effective assessment activities. A PhD in educational research and evaluation, Filer seeks to develop and test innovative assessment methods.

Julie S. Lyon, PhD is an assistant professor in the Business Administration and Economics Department at Roanoke College. Lyon received her BA in psychology from NC State University and her MA and PhD in industrial-organizational psychology from the University of Maryland, College Park. Lyon’s research interests include diversity and staffing, climate and culture, and the scholarship of teaching and learning, and her work has been published in the Journal of Applied Psychology. Currently, she serves as the director of student-faculty research at Roanoke College.
Faculty members struggle to balance competing demands on their time, including being effective teachers, mentoring students, conducting research, serving their institutions and professions, and assessing student-learning outcomes in courses and the overall curriculum. Faculty members at Capital University in Columbus, Ohio, have successfully integrated these competing demands through undergraduate research, and we can demonstrate how undergraduate research projects have led to institutional change. Most of the projects we discuss address issues experienced on many campuses (e.g., academic advising and parking) and across many academic disciplines (e.g., assessment and student awards), and thus the projects can be replicated at a wide range of colleges and universities that value undergraduate research.

The undergraduate research experience is the primary focus of each project we’ll describe, but benefits also flow to the institution from the student researchers’ conducting a high-quality project. In the projects described below, students have had a complete undergraduate research experience, from reading the relevant literature and developing a meaningful research question and method for answering that question, through collecting and analyzing data, to disseminating the results at campus and professional venues. Having students communicate their work to both lay and professional audiences helps students understand that they must tailor their language and message to the audience’s level of knowledge about a subject. This appreciation of audience is, of course, a key skill needed when interviewing for internships, jobs, and graduate programs and indeed for talking with anyone outside of one’s discipline. The dissemination venues for our students’ projects illustrate the variety of audiences with which the students learned to communicate and demonstrate that these projects are valued by the broader academic community beyond Capital University.

Each project described below was supervised by one or both of us, and some were also co-mentored by other faculty colleagues in other disciplines. As required by the institution’s guidelines for the use of human subjects in research, the projects described either received approval from Capital University’s Institutional Review Board (IRB) to collect data from human participants or met the institution’s criteria for being exempt from IRB review.

Following are descriptions of undergraduate research projects that had an impact at the institutional, departmental, or program levels.

### Institutional Impact of Undergraduate Research Projects

At the institutional level, undergraduate research has changed academic advising at Capital University. In 2007 the university’s provost announced that the faculty must assess its methods for academic advising in order to improve the services that the university provides. The institution’s model for advising is that each faculty member is the primary advisor for approximately 20 students, although the range of advising loads is from 5 to 60 students. The undergraduate research project that arose from the provost’s directive led to a collaboration between the institution’s faculty development committee and a group of student researchers.

The faculty committee read the research literature about academic advising, articulated academic advising goals, and drafted a questionnaire seeking information about academic advising at the university. Prior to using the survey, we wanted to ensure that it was a reliable and valid assessment of advising. An undergraduate research team of four students also read the research literature about academic advising and how to develop scales for research and assessment purposes and then conducted three studies to determine the questionnaire’s psychometric properties. Student researchers surveyed senior faculty to establish content validity, ran student focus groups to examine face validity, and demonstrated test-retest and internal reliability of the questionnaire with another student sample. This work was presented at Capital’s annual Symposium on Undergraduate Scholarship and at a college faculty meeting. The students published the work in the campus journal for undergraduate research and also presented the work at the annual convention of the Association for Psychological Science.

Before fully implementing the advising survey, another student conducted a pilot test of two methods for administering the survey (i.e., online administration and interviews), examined additional psychometric properties (i.e., survey-
then created three surveys—for incoming students, current students, and employees. The surveys requested information about where respondents lived and their commuting and parking habits. Recognizing that building more parking lots is neither desirable nor feasible, we wanted to examine ways to reduce the need for parking, and thus the surveys investigated attitudes toward alternative modes of transportation to assess what resources and education would be needed to change commuting behaviors. The survey for incoming students also examined the value of having a car on campus relative to other factors that the students considered when electing to attend Capital University. This work was presented to staff and administrators who serve on the university’s “parking sustainability” committee and has been used to help inform the parking and commuting-related aspects of the institution’s master plan. The work was also presented at Capital University’s undergraduate research symposium and is scheduled for publication in the university’s research journal.

Prior to these student research projects, there was no formal, campus-wide process for evaluating the quality of academic advising on campus. The AAS (available at http://www.capital.edu/psychology-resources/) now is used to assess academic advising on campus and is part of the faculty evaluation process for promotion and tenure. The feedback provided by the AAS lets faculty know their strengths and weaknesses as academic advisors so that they can work toward meeting students’ academic advising needs. The gap analysis research is also being used as part of the assessment evidence for Capital University’s current accreditation self-study. Clearly, this work impacted the university in multiple ways.

Also at the institutional level, students were commissioned to do research about parking on campus. With the assistance of Terry Lahm, a professor in Capital University’s biological and environmental sciences department, the student researchers read the literature about campus driving, parking, and commuting (yes, there is a research literature on this), and interview reliability), and replicated the internal reliability of the measurement scale used. This same student researcher also conducted a “gap analysis” to determine students’ relative valuing of the advising behaviors identified in the questionnaire. This analysis provided a starting point for faculty conversations about improving academic advising by highlighting the areas where faculty, as a whole, were least likely to meet the students’ expectations. Stephen Bruning, a faculty member in Capital’s communication department, was a faculty co-mentor for the gap analysis research. Just as with the validation study, this research was presented at Capital’s undergraduate research symposium and at the annual conference of the Ohio Psychological Association. It is scheduled for publication in the campus undergraduate research journal.

Departmental Impacts of Student Research
At the department level, undergraduate research has affected how we assess the student-learning outcomes of our psychology curricula. Accrediting agencies emphasize programmatic assessment that leads to program improvement; course assessment, alone, is no longer sufficient. Our provost mandated integrated program assessment and set a deadline for implementation. Our psychology department needed a new assessment plan that was easy to administer, had student and faculty buy-in, and had the ability to provide data that could then be used to make changes in the department. In addition, during an assessment in-service day, an external speaker admonished the faculty for not including student perspectives in our departmental assessment plans, given that most assessment data come from students. To address this critique and give students practical experience with research issues, psychology faculty members created an activity for our research students. We directed them to help us derive ways to measure students’ attainment of the department’s learning goals. The students had been studying research methodology all semester, including program assessment, so they were familiar with assessment techniques and some of the literature regarding assessment of learning outcomes. The decision to have students assist with the development of an assessment plan had benefits for both faculty and students: Department faculty learned what the students were and were not willing to do as participants in the assessment activities, for example, compile a portfolio of written work or attend a session outside of class time in order to complete a test of overall content knowledge of

Kelsey Hutchinson, a public relations major and psychology minor at Capital University, explains her research about academic advising to Jody S. Fournier, professor of psychology and assistant dean.
conducted research to determine whether having awards was a catalyst for change on campus, student researchers also presented their work at the campus research symposium and at the annual conference of the Association for Psychological Science. As a result of this work, the psychology department has a comprehensive assessment plan, as well as student buy-in for collecting assessment data from them.

Student Researchers’ Impact on Programs
Smaller undergraduate research projects have informed programs, courses, and events. For example, students conducted an undergraduate research project to assess a program to educate student athletes about relationship abuse. The Columbus Coalition against Family Violence, through the “It’s Abuse” campaign, developed educational programming to teach college students about relationship violence so that students could recognize dating violence when it was occurring and take appropriate action. The coalition asked to test the effectiveness of its programming at Capital University with a sample of student athletes. A group of student researchers helped to develop the assessment method, and students collected and analyzed the assessment data. They presented their work to the campus community and at the Ohio Undergraduate Psychology Research Conference and at the National Conference on Undergraduate Research.

Student researchers also helped to evaluate a novel, grant-funded integrated mathematics and science course. This research was co-mentored by Marsha Nicol, a faculty member in Capital’s education department who was principal investigator on a grant from the Ohio Board of Regents to develop an integrated mathematics and science course for pre-service middle-school teachers. This course was to become part of the university’s computational science program. As part of the grant, after the first time the course was offered, student researchers developed a way to assess the effectiveness of it, using a mixed-method evaluation. This assessment then informed subsequent offerings of the course. The student researchers presented their work at the campus research symposium and at the annual conference of the Association for Psychological Science.

In a final example of how undergraduate research has been a catalyst for change on campus, student researchers also conducted research to determine whether having awards during our annual student research symposium would affect participation. The committee that organizes the research symposium had debated, repeatedly, the costs and benefits of having such awards. The primary concern was that awards, and the evaluation process that accompanies them, would dissuade some students from presenting their work. Recognizing that the generation of students being served by the research symposium was different than that of the faculty serving on the committee, the panel members decided to use a student research group to explore student attitudes about awards for presentations at the symposium. The student researchers developed a method for assessing student attitudes on this topic and then surveyed the student population. Much to the planning committee’s surprise, students said that they wanted to be evaluated for awards during the symposium and that they wanted feedback about their presentations, regardless of whether they received awards. The university now has an endowed award for presentations at the symposium. The research about students’ attitudes toward awards was presented at the National Institute on the Teaching of Psychology.

Conclusion
Each year we ask students to provide comments about their research experiences and present the results of their work at our student research symposium. Their responses indicate that through undergraduate research experiences, students develop the work and mental habits of scientists, build their academic and laboratory skills, obtain career guidance and preparation for graduate school and careers, elevate their attitudes toward learning, and improve their sense of self-efficacy. When students conduct research within the context of their own institutions, they also gain a deeper sense of personal satisfaction from knowing that the work they are doing is directly benefitting their friends and classmates and future students.

We have described only a few examples of how undergraduate research experiences can serve more than just student researchers and their faculty mentors. The kind of research we’ve described has the potential to serve institutions by providing much needed data that can inform decision making and advance the priorities of the institution itself. The results from undergraduate research projects at Capital University have changed the quality of academic advising by giving faculty a valid and reliable tool for obtaining feedback about their advising, promoted assessment at the department and program levels, informed policies for parking and the institution’s master plan, and improved our campus-wide undergraduate research event. By integrating, where appropriate, undergraduate research experiences with institutional needs and initiatives, the faculty members who
mentor these experiences are able to simultaneously accomplish many tasks (e.g., supervise undergraduate research, fulfill committee obligations, and meet assessment requirements). This efficiency ultimately results in greater faculty productivity and, we hope, greater faculty satisfaction with their work.

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Jody S. Fournier is a professor of psychology and assistant dean of the School of Social Sciences and Education at Capital University. A developmental psychologist, he studies scientific and nonscientific beliefs in children and adults and engages in pedagogical research. He mentors undergraduate research students on topics that range from perspective taking to meta-perception. He earned his bachelor’s, master’s, and doctoral degrees at the Ohio State University.

Andrea M. Karkowski, a professor of psychology at Capital University, teaches a sequence of courses (statistics, research methods, and experimental psychology) that emphasize the development of research skills so that students are prepared to conduct their own independent research. She has mentored dozens of undergraduate research students. She earned her bachelor’s degree in psychology at Lock Haven University and her master’s and doctoral degrees in psychology at the University of Montana. She also has a master’s in business administration from Franklin University.

New CUR Book!

Undergraduate Research Offices & Programs: Models & Practices
Joyce Kinkead and Linda Blockus

In 2000, the Council on Undergraduate Research (CUR) published How to Develop and Administer Institutional Undergraduate Research Programs, by Toufic Hakim. Although only 75 pages, Hakim’s book had a powerful influence on developing undergraduate research programs. This book has much the same aim—to provide models of undergraduate research programs that can instruct and inspire. It is the next-generation reference book and manual for those who are seeking to start or enhance existing undergraduate research programs, drawing on the wisdom and experience of more than 25 contributors. Showcasing offices and programs of undergraduate research at a variety of institutional types at various points of maturity, each of the model chapters is devoted to an institutional type and follows a template, thus making it easy for the reader to browse chapters and trace a particular theme: mission, resources, events, publications, and even challenges. The volume also offers pragmatic advice on assessment, special programs, and summer experiences. Sharing ideas and resources is a hallmark of the Council on Undergraduate Research, and it is in this spirit that Undergraduate Research Offices and Programs: Models and Practices was developed.

To order this and other CUR publication visit: http://www.cur.org/publications.html.
Broader Impacts of Undergraduate Research at a Community College: Opening Doors to New Ideas

Community colleges are in a strategic position to offer students opportunities that they might not otherwise have had. Many community-college students choose their institutions because community colleges offer them a local opportunity to pursue their education at a more affordable cost and in smaller class sizes than is typical at a four-year public institution. However, developing an undergraduate research program in this environment can be difficult for a multitude of reasons, with lack of financial support from the institution or other sources and the short-term, transient nature of the student population being two of the most prominent drawbacks.

State Fair Community College (SFCC) in Sedalia, Missouri, is no exception, as the institution serves a strongly rural, 14-county area; many of its students use the college to launch their postsecondary careers. And yet, a single undergraduate who was determined to conduct a particular independent research project helped spark an interdisciplinary collaboration that ultimately resulted in new curricula that offer SFCC students a chance to conduct scientific research.

Demographics at State Fair Community College

SFCC is a comprehensive public two-year postsecondary institution that offers programs leading to certificates, associate of arts degrees, and associate of applied science degrees in 23 disciplines. Typical annual enrollment is approximately 3,500 students. On average, more than 51 percent of the student body is made up of part-time students, with an overall average age of 26. Nearly 89 percent of our students receive financial aid; about 50 percent are economically disadvantaged. Approximately 80 percent are first-generation students who work full-time jobs while pursuing their education; 79 percent of our students also require developmental coursework before taking any courses that can be applied toward a degree. Consequently, many of them are ill-prepared to take a postsecondary-level introductory science course.

Approximately 250 to 300 students per year enroll in and complete our science courses that include a laboratory (class size is typically 20 to 24 students). Of those students, approximately 225 to 275 are non-science majors taking an Introduction to Biology, Introduction to Chemistry, or Introduction to Earth Science course to fulfill their general-education requirements. Better than 75 percent of the non-majors transfer to the University of Central Missouri, a four-year institution 30 miles west of SFCC, while our science majors transfer to various four-year institutions throughout Missouri. The non-science majors taking science lab courses are dominated (approximately 35 percent) by students majoring in elementary education, who are required to take two laboratory science courses. The second largest group (approximately 30 percent) consists of students interested in entering our vocational health programs (e.g., nursing, dental hygiene, and radiology). The remaining 35 percent of non-science majors are studying other disciplines (e.g., art, history, sociology, psychology, criminal justice, etc.).

Approximately 25 students per year are science majors expecting to fulfill their freshman- and sophomore-level science coursework at our institution. Within the science majors, most students intend to pursue careers in one of the health professions, followed by conservation/environmental professions, and teaching secondary mathematics and science. While a few others intend on pursuing advanced degrees in pharmacy or various biological fields, an even smaller number of students intend to pursue degrees in chemistry, engineering, or physics. As noted above, a large portion of the students who attend SFCC work full time and many others work at least part time outside of the college.

In terms of the financial situation at SFCC, the institution is very much like other small, state-supported colleges; it has limited resources and few or no dollars to support the additional costs that often accompany undergraduate research. Even if money were available, much like other community colleges, the high teaching loads allow faculty members little time and opportunity to pursue external funding. Consequently, any additional costs to implement and conduct undergraduate research must be absorbed within departments’ annual budgets.

In spite of all these limitations, a single, student-initiated undergraduate research project inspired the SFCC faculty to embrace undergraduate research through the development of new curricula and integration of student research in both chemistry and biology courses, providing students opportunities to conduct semester-long research projects as...
part of their normal coursework. The initial project stemmed from a pharmacy student concurrently enrolled in the first-semester biology and first-semester chemistry courses. Her persistence and strong desire to pursue an undergraduate research project (by replicating the 1953 experiments of Stanley Miller and Harold Urey on the “pre-life” evolution of the molecular building blocks of complex biological molecules that are required for life to exist, Miller 1953; Miller & Urey 1959) were all she needed to nudge her professors into a long-lasting, cross-disciplinary collaboration focused on integrating student-initiated research projects into the undergraduate science curriculum. Not only was this initial project successful in meeting its objective, it also led students and faculty alike to realize that high-quality research projects can be accomplished at small rural colleges with little or no research budget.

Although the student-led replication of such a historically important experiment provided innumerable opportunities for all students participating in the project to learn basic biochemistry and provide context for the scientific process, the “real” success was observed by watching a group of students from various disciplines come together in an authentic collaboration using teamwork to solve problems. As this original student project developed, additional interest became apparent from other students, and under faculty recommendation a small student research group developed to tackle the project. This student-led research group was able to take advantage of individual strengths and minimize their weaknesses as they built their experimental apparatus with minimal expenditure. From building their own manometer to measure atmospheric pressure within their reaction chamber to utilizing an automobile distributor, a car battery, and an electric hand-drill to generate the regularly occurring spark necessary for their experiment, the students overcame their anxiety about doing scientific research and realized that what they once felt was beyond their reach was definitely attainable. Moreover, this group of students’ attention to detail enabled them to recognize the potential for obtaining a false positive during the first run of their experiment and subsequently led to modifications to their experiment that eliminated their false positive and subsequently produced a legitimate positive result. Ultimately, the success of this undergraduate research project resulted in an increase in student independence, responsibility, and self-motivation, evident in the students’ request to present their research at the annual Missouri Academy of Science Conference.

Motivated by this successful UR experience, the SFCC biology and chemistry faculty seized an opportunity to modify the current curricula in the first-year sequence of biology and chemistry courses by integrating significant cross-discipline research components into the respective coursework. Over the course of three years, the curricula of biology and chemistry courses for both science and non-science majors were modified to place less of a priority on content knowledge and more of an emphasis on the real-world, collaborative effort of scientific investigation. Specifically, the focus was shifted to how we know what we know, and not just what we know. Such an undertaking included the first-year sequence of courses for science majors, Chemistry I & II and Biology I & II (courses with typical enrollments of 15 to 20 students each); the non-majors’ Introduction to Chemistry and Introduction to Biology courses (typical enrollment of 24 students per section with three to five sections offered each semester); and a new two-semester Introduction to Biotechnology sequence (with a typical enrollment of 10 students in one section each semester).

The shift from “content-driven” curricula to “process-driven” curricula was initially difficult, as on the surface faculty feared that the change in priority could and would lead to the loss of content learning. However, faculty quickly recognized that objectives for students’ content knowledge could still be met by placing a greater expectation of content knowledge on the students as they pursued the research projects integrated into their coursework. Ultimately, these changes enabled faculty members to make more authentic assessments of student performance based on their content knowledge as demonstrated through hands-on application of course material. For example, students in the introductory chemistry course were expected to “silver” a bottle for one of their course exams. The assignment required stu-
students to work collaboratively in small groups to identify an appropriate procedure, make appropriate calculations, and perform standard lab procedures by mixing solutions prior to each of them performing the procedure independently. If the procedure they used was not appropriate, errors in calculations or errors in the preparation of solutions were made, with the results of the errors clearly visible on the bottle produced. Additionally, having an interesting, new display item created by each student gave the students ownership of their learning that led to deeper appreciation of science in general.

In another example, in one of the new introductory biology and chemistry courses the midterm exam required students to work collaboratively in small groups to develop a procedure to identify and quantify the individual constituents in an unknown solution of biological molecules. Over the course of one week, the students had to determine appropriate procedures, explain why they chose these procedures, assign various tasks to each member of the team, identify the particular components of the solution, produce appropriate standard curves to aid them in quantification of substances, and generate a final group report of their results. Students not only had to demonstrate their knowledge and lab skills but also their ability to function in the dynamic, collaborative process of science.

With such a change in focus to emphasize the scientific process, the improvements in students’ understanding of experimental science and the scientific method anticipated by the faculty became readily apparent as students enrolled in and completed sequential science courses. As students progressed through their biology and chemistry sequences, they began to recognize their own abilities to seek out the information they felt was necessary to understand and complete the experiments they were attempting. Furthermore, students began to ask deeper, more thoughtful questions in pursuit of knowledge beyond what was expected in the course outcomes. In effect, they were becoming scientists.

What more could we ask for? Unexpectedly, this question was answered because these students began to seek out additional research opportunities. For example, a group of biology and chemistry students who were all enrolled in the second-semester biology and chemistry courses in those disciplines’ curricula asked to conduct a research project monitoring water quality in the local community. With support of the Missouri Stream Team Program, these students collaborated to assess water quality in the entire watershed in which SFCC is located. Their efforts established a long-term, community water-quality monitoring program in which many students still participate.

Other inspired students chose to continue the “replication of historical research” approach that initiated undergraduate research at SFCC originally. After learning of the 1958 Meselson-Stahl experiments, which established our understanding of how DNA is replicated, a student inquired about the possibility of replicating this important work. Stimulated by this request, another pair of students was curious about replicating the 1952 Hershey-Chase experiments identifying DNA as the molecule of inheritance. Both of these experiments presented hurdles the students needed to overcome: The Meselson-Stahl experiments required a high-speed centrifuge, which was not available, and the Hershey-Chase experiments required radioactive isotopes whose use was not feasible logistically. The students in both of these projects sat down together and came up with a solution that benefited all of them by utilizing stable isotopes and modern electrophoresis techniques to separate chemical products by their mass. This minimized the cost of each project and led the students to successfully replicate the original research using modern techniques. Yet another group of students was inspired by the historical extraction of salicylic acid from willow trees and attempted to make such an extraction and convert it to aspirin. Although unsuccessful, their attempt at synthesizing aspirin inspired another group of students to successfully synthesize TNT in a project examining the illicit transport of TNT dissolved in gasoline. Further, an art student was inspired to investigate the chemistry and synthesis of paint pigments, which in turn led to an entire series of artistic works.

One factor that has aided in the stimulation of new student-generated research projects is the end-of-semester seminar that has been institutionalized at SFCC for some time. Initially, this conference was established as part of the curricular changes in the biology and chemistry courses for science majors, in which students were required to present their group and/or individual research projects. After the first two years of curricular change, the conference was incorporated into the science courses for non-majors as well. Subsequently, as the embedded course research projects began to inspire additional, extracurricular research projects, the one-day conference for course projects ultimately expanded to three days to accommodate all the presentations from biology and chemistry majors, non-majors, and these students’ independent research projects. This end-of-
semester research conference grew beyond any expectation as faculty, staff, and students campus-wide began to attend the conference at some point over the three-day period. Essentially, the integration of research into the undergraduate science curriculum at SFCC shifted a science program that had only rarely had a student interested in pursuing research to a program with an average of 36 group research projects conducted as part of coursework per semester (with working groups of from two to four students), plus from four to 10 group and individual research projects each year conducted outside of coursework.

Surprisingly, an additional impact from the undergraduate research program at SFCC was made clear as students began to request research opportunities from faculty members in other disciplines. Not only were there requests in other sciences, but also in history, psychology, and sociology. At the last end-of-semester conference, invitations to present their research were extended to students in all disciplines at SFCC. Although no one from outside the science disciplines accepted this invitation, time will tell if the conference expands into all disciplines.

The institutional attitude toward undergraduate research has changed considerably. Even though SFCC faculty have such high teaching loads that they are afforded little opportunity to pursue additional scholarship, a sense of true “teaching scholarship” began to develop as the integration of undergraduate research into the curricula became the common practice in the sciences. Most notably, scholarly collaborations began to evolve. Not only were student/student and student/faculty collaborations becoming more common, but more faculty/faculty collaborations also developed. Although collaboration among science faculty members was the foundation of the initial changes, the small number of faculty and the increased demand for research opportunities necessitated deeper collaboration efforts in order to manage the research projects students wished to pursue.

Moreover, the small number of science faculty also meant a smaller pool of expertise to draw upon, which increased the need to rely on each other to find sufficient expertise to cooperatively supervise the undergraduate research projects across disciplines. Once these collaborations were recognized across the campus, other cross disciplinary faculty/faculty collaborations began to develop. For example, three faculty members—one each from biology, sociology, and psychology—worked together to develop and offer a research-based course on human sexuality. Another collaboration between biology and history faculty members led to significant improvements in teaching the historical context of conservation efforts in a wildlife conservation course. And another collaboration developed between chemistry and English composition faculty to offer a pair of courses in chemistry and compositional writing. Students in a chemistry course for non-majors use their experiences in the course as the basis for much of the writing they are assigned in their composition course.

Even with all of the outcomes discussed here, the most important result is the impact that the incorporation of undergraduate research into the curriculum and the offering of extracurricular research opportunities have had on students. A noticeable increase in student confidence became apparent through an increase in students’ ownership of their own education; they became more self-motivated, independent thinkers taking responsibility for their own learning. Increased student confidence resulted in increased course retention; many science courses at the beginning of this process had retention rates of less than 60 percent but at the end of this process, their overall retention rate was more
than 90 percent. Students demonstrated, and continue to demonstrate, a greater desire to pursue careers in or related to research. When considering the impact on students and the institution at large, we were left with one question: Why didn’t we do this before?

References

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LaRoy Brandt received a PhD in entomology from the University of Kansas, his MS in biology from the University of Central Missouri, and his BS in biology from Missouri State University. Brandt conducted numerous undergraduate projects, and studied the ecology of prairie mole crickets for his MS thesis and the behavioral ecology of the lesser waxmoth for his PhD dissertation. He taught various biology courses for State Fair Community College from fall 2002 through spring 2010. During his time at SFCC, he served for five years as department chair and managed to obtain external funding to develop a biotechnology program. For the past four years, Brandt has taught summer courses in tropical ecology, entomology, and field photography at the LaSuerte Biological Field Station in Costa Rica. Currently, Brandt is an assistant professor of biology at Truman State University in Kirksville, MO.

Jack Lee Hayes has a master’s of science in analytical organic chemistry from Indiana University Bloomington, a masters of art of teaching adult and distance education from The University of Phoenix. Jack has served in the US Navy as an engineering laboratory technician (submarine qualified). Additionally, he was a project manager for Chem. Nuclear Inc., conducting waste disposal and site remediation. He conducted undergraduate research in environmental chemistry focused on surface water nutrients, and conducted graduate research in analytical electrochemistry for catalyzed reduction of chlorofluorocarbons. Hayes has served for eight years at various community colleges, teaching basic skills courses in addition to non-major, allied health, elementary organic, and introduction to biochemistry courses. For the past six years, Hayes has served as the lead chemistry instructor at State Fair Community College in Sedalia, MO where he teaches introductory chemistry, general chemistry, and organic chemistry courses.

Call for Abstracts
Posters on the Hill
Spring 2013- Washington, DC

Nothing more effectively demonstrates the value of undergraduate research than the words and stories of the student participants themselves. In spring 2013, the Council on Undergraduate Research (CUR) will host its 17th annual undergraduate poster session on Capitol Hill. This event will help members of Congress understand the importance of undergraduate research by allowing them to talk directly with the students involved in such studies.

CUR invites undergraduates to submit an abstract of their research that represents any of CUR’s divisions (Arts and Humanities, Biology, Chemistry, Geosciences, Health Sciences, Mathematics/Computer Science, Physics/Astronomy, Psychology, and Social Sciences). To ensure proper review of applications, the above are the only disciplines in which students may apply. In the case of research that is interdisciplinary, students should select the division that most closely describes the research.

Directors of undergraduate research, faculty members, and other involved administrators are urged to encourage their students to submit posters. This is a highly competitive program and a very exciting experience for both students and their faculty advisors.

Visit www.cur.org for additional information and to apply.

The deadline for submissions is November 1, 2012.
The Impact of Student-Directed Research at an Undergraduate Liberal Arts Institution

Ferrum College, an undergraduate-only, primarily residential institution with approximately 1,500 students, focuses on effective teaching and learning through the use of high-impact educational practices. This means that all three academic schools in the college strongly emphasize undergraduate research. In particular, faculty members in the School of Natural Sciences and Mathematics rely on student participation in undergraduate research for much of their scholarly professional development, often allowing students to determine much of the research conducted, rather than following the traditional pattern of allowing external funding to determine faculty research.

Student-directed research programs allow faculty members to be creative and flexible and broaden their interests; however, the student-directed approach is poorly suited for traditional, grant-funded research.

In this article we provide several vignettes about students who participated in “student-directed” research at Ferrum and how the projects affected them and also influenced the scholarship of faculty and the curriculum of the School of Natural Sciences and Mathematics. The vignettes demonstrate how students’ ideas have shaped the scholarship programs of the faculty researchers involved, moving them from the narrow and deep research model that is typical in graduate education to a slightly shallower but much broader model that emerges from student-directed research. Student-directed undergraduate research, in fact, has been a learning tool for students and their faculty mentors, as well as affecting the academic programs in natural sciences and mathematics.

Ferrum College was founded in 1913 by members of the United Methodist Church to bring literacy to underserved children in the Virginia Blue Ridge region of Appalachia. From that humble beginning and with a motto of “Not Self, But Others,” the college has evolved into an applied liberal arts institution; about 30 percent of our students are the first in their family to attend college. Ferrum provides students with hands-on learning opportunities in all areas of study. One example is found in our Experiential Term, a three-week session in May in which students and faculty focus on a single course, and each of the available courses has been specifically designed to provide students with experiential learning opportunities.

Laboratory instruction and undergraduate research are natural expressions of experiential learning in the natural sciences. We purposely recruit faculty members who are interested in teaching and involving undergraduates in research. This has added to our distinction of being a close-knit academic community in which faculty and students work closely together both in class and beyond.

Student-directed Research

At most institutions, the typical model for a scientific research program follows three basic steps: a faculty member develops a research topic (initially this is usually an extension or modification of a Ph.D. or postdoctoral project), obtains funding, and proceeds to examine that topic in-depth over many years. In the sciences, that last step often involves a combination of technicians, graduate and undergraduate students, and postdoctoral fellows assisting with the research. While that is the common model for a research-focused university, it is not the only successful model for research, especially at teaching-focused undergraduate institutions.

In contrast to the traditional model, at Ferrum College numerous faculty members have adopted the “student-directed” research approach. Instead of following a specific set of procedures each week, students are allowed to explore a research project of their own design (Goyette and DeLuca 2007, Katz 1996, Usherwood et al. 2009). Student-directed independent research encourages students to creatively examine their research interests and to design a project for investigation, under faculty supervision. This approach contrasts with standard scientific undergraduate research that models a more passive learning environment, in which the student is told he or she will be working on a specific subset of the faculty researcher’s project and is given specific protocols to follow. In the traditional scientific model the students frequently wind up collecting data, but are not given the opportunity to also be involved in hypothesis building, experimental design, and data analysis. Yet those are all key skills that students should possess upon graduation.
In the following examples of successful undergraduate-directed research projects at Ferrum, students’ ideas have shaped the scholarship of the faculty researchers involved. Faculty mentors benefit by stretching the scope of their knowledge and methodologies into new and interesting fields, and the particular academic program and the college benefit because the faculty knowledge gained is used to generate new curricula and course projects. Vignettes 1 and 2 illustrate approaches to strictly student-directed research projects, while vignettes 3 and 4 provide examples of how student-directed research approaches can be blended with a more traditional research model.

**Vignette 1: Studying Antibiotic Resistance from the Environment to the Classroom**

One goal of developing student-directed research may be to promote and encourage a student’s natural curiosity. This project began with a student asking a simple question: She wanted to know what the white stuff on the surface of her throat was. Instead of answering, I (Michaela Gazdik) asked if she wanted to investigate it using a microscope. The student was very excited by the offer, and that excitement and desire for knowledge were used to turn the student’s question into a semester-long research project.

Students do not always ask questions solely in the faculty member’s area of expertise, so faculty must be willing to delve into research areas that may not be related to their training or education. In this instance the student was interested in whether the bacteria swabbed from her throat were resistant to antibiotics. Unfortunately that was not a reasonable research project because of the safety concerns related to the possibility of finding antibiotic-resistant human pathogens. However, we used her interest to develop a similar project.

The student collected microbes from the environment, identified them using molecular methods, and examined their resistance to key antibiotics. At the start of the project I had a basic textbook knowledge of the molecular methods needed, but I had never used them in a laboratory and my specialty was neither antibiotic resistance nor environmental microbiology. However, together the student and I researched needed supplies, costs, funding, and a timeline for the project—thus allowing the student to observe important steps in the research process. She learned about project development, as well as how to perform the research itself. She obtained and analyzed her data using critical-thinking skills and presented the results at a regional conference, helping to improve her communication skills (Wilson and Gazdik 2009). This experience encouraged her and gave her the confidence to apply to professional programs after graduation.

At the same time, this project was a great professional-development opportunity for me. I learned a great deal about molecular identification techniques and new technologies in the field. From this new knowledge I have developed a research assignment for our general microbiology course. The assignment is based on the protocols developed and insights discovered during the course of the independent research project. By modifying the project and incorporating it into my 300-level course, I have generated an inquiry-based laboratory project that will expose numerous students to the concepts of independent research.

**Vignette 2: Interdisciplinary Chemistry Research Impacts Curriculum**

I (Jason Powell) have allowed individual students’ interests to strongly influence my research program over the past ten years at Ferrum. From the freshman who declared “I want to blow stuff up” (and eventually presented the results of his work related to ancient chemical weapons at a national American Chemical Society meeting) to the nontraditional student who used proprietary research at his employer to inform and expand his on-campus work, their projects have helped me greatly expand my own expertise beyond my undergraduate and graduate research experiences (Dye and Powell 2007, Powell 2008).
A typical chemistry student will take a one-semester practicum course (pass/fail) in which he or she learns the basic techniques involved in a proposed research project. In subsequent semesters, he or she will enroll in a sequence of independent research courses (graded) in which written and oral presentation of results is required. Six years ago, the chemistry program developed an Experiential Term course called Advanced Chemistry Laboratory, partially as a result of my experience.

In this “E-term” course, students learn key techniques in group settings early in the three-week term, practicing them using previously published data. In the second and third weeks of the course, they then apply the same techniques to previously unpublished problems in a collaborative atmosphere. The final assessment in the course is a poster-style presentation and formal report on each project, made to the research supervisor and peers from the class, as well as to interested faculty and staff from other areas of science.

Vignette 3: Student-Directed Research as Part of a Traditional Research Program

Student-directed research can encourage students’ excitement and commitment to a research project, but the approach does have drawbacks if you have specific grant-funded projects that must be accomplished. In order to complete that research you must use a more traditional approach. While I (Gazdik) believe student-directed research is beneficial to students’ learning, my laboratory also has a traditional research program funded by the National Institutes of Health. In my lab I have blended traditional and student-directed research approaches by modifying how students are recruited to the project.

Students interested in research are provided with a copy of my funded grant and are allowed to choose which portion of the project they are most interested in. My overall grant aims to examine gene regulation in the bacterium Mycobacterium smegmatis. Students have chosen projects based on the regulation of a specific gene or regulation of many genes in a particular environment they were interested in. Students then write their own mini-proposal, stating how they will accomplish that part of the project and develop a timeline for their research. This method has been very successful with students, many of whom have presented their work at regional and national conferences, such as the Annual Biomedical Research Conference for Minority Students (Ford and Gazdik 2010). By giving students a choice, I was able to move my project move forward while allowing students some flexibility in how they conducted their portion of the research.

Interestingly, I have found that this method also translates well in the classroom. I have used similar concepts to encourage students to complete projects that interest them instead of projects I designate. When students are researching information that they are interested in, they become more engaged in the material. Students who have control over their project design feel more pride in and ownership of their work and therefore tend to put more effort into the project. I now utilize this approach in a number of my courses.

Vignette 4: Environmentally Friendly Water-Quality Analysis

For the past 24 years, our colleagues Carolyn Thomas (biology and environmental science) and Dave Johnson (chemistry and environmental science) have been studying water quality on Smith Mountain Lake. They have expanded their work also to other lakes, rivers, and streams in the region through the involvement of dozens of students and citizen volunteers over the years. I (Powell) became directly involved in the project about six years ago as the scientist supervising chemical and instrumental analyses for the project. Using standard methods to analyze water quality, our students measure dissolved oxygen concentration, conductivity, temperature, Escherichia coli bacterial counts, algae counts, water clarity, chlorophyll-a concentration, and total phosphorus concentration. All our analytical techniques are certified by the state as equivalent to those performed in their own labs for inclusion in state and federal water-quality reports.

One parameter that was previously included but is no longer measured by our lab is nitrate nitrogen concentration. It was discontinued because the method used generated cadmium-
containing waste and also because the results did not meet the level of quality assurance that was desired. Because of the importance of nitrogen as a nutrient, one student was particularly interested in finding alternative measurement methods. She worked independently, with input from Johnson and me, to explore the use of three complementary procedures to measure nitrate nitrogen, ammonium nitrogen, and total nitrogen concentration. Her work resulted in a pilot study the next summer to introduce those techniques as part of our standard battery of techniques. Unfortunately, they did not result in high enough quality-control standards to be used, but the results provided sufficient justification to eventually purchase a new piece of analytical equipment recommended by our peers to allow us to again measure total nitrogen. Although this represents a traditional research program in the sense that its main focus is determined by the faculty investigators, one student’s particular interests and her resulting work strongly influenced the ongoing research in the program. She wasn’t able to present her results beyond our on-campus settings, but other students have made presentations related to their experiences on the project.

Vignette 5: Other Natural Science Research

Many of our colleagues have taken similar approaches with far-reaching impacts. Natalia Smelkova, a biochemistry faculty member, mentored two students who received National Science Foundation scholarships from the Appalachian College Association (ACA) while performing research on DNA amplification using the technique of Multiple Displacement Amplification (MDA). Those students presented their work at regional scientific meetings as well as at an ACA Summit (Martin et al. 2009), and Smelkova has since introduced an MDA experiment into the laboratory portion of Ferrum’s biochemistry course.

Glen Stevens, a faculty member in biology and environmental science, has pioneered the use of individual student research projects across all sections of the fundamentals of ecology course; students work on semester-long research projects related to core principles. Chris Aylesworth and Katie Goff, faculty members in biology, have implemented project-based learning in their human anatomy and physiology laboratories. Todd Fredericksen, a faculty member in environmental science, involves students at all levels in his ongoing research related to forest regeneration and small-animal habitats (Fredericksen et al., 2006, 2007, 2008, 2009, 2010, 2011). Bob Pohlad and Carolyn Thomas, biology faculty members, have helped several students develop studies related to watershed research. Several students have received Ledford Scholarships from the ACA to support summer research for which they earn internship credit. One example is a student who conducted summer research on various factors influencing the growth of peanuts and other crops (Hawkins and Byrd 2011).

These are a handful of examples of how a relatively small school at Ferrum College has had prolific student involvement in significant learning through undergraduate research. The focus begins in introductory courses and often results in students completing a significant independent research project as part of a senior-year research paper and presentation. These experiences can count as part of the required capstone experience in the student’s major.

Funding and Tenure Concerns

Two concerns are typically raised when the student-directed model of research is discussed. The first is whether faculty researchers can be competitive for external grants when their research lacks the narrow focus of faculty-directed research. For any research program, the biggest challenge is (and always will be) finding money to conduct the work. Funding agencies and their reviewers are accustomed to evaluating and ranking proposals based on established criteria developed for well-defined, focused studies with clear goals, methods, projected expenses, and intended outcomes. Student-directed research has an element of uncertainty that makes it poorly suited for the traditional, grant-funded approach. As a result, faculty researchers who engage in student-directed research must be flexible and creative in the ways they pursue and support this work.

An institution that has student learning at the core of its mission must support such student-oriented research efforts with internal funds wherever possible. Also, faculty researchers sometimes can find creative ways to collect multiple student projects into a coherent program that will compete effectively for external funding. Many faculty members at Ferrum will outline specific areas of interest within which students can develop project ideas, and this approach has yielded some success in winning small external grants.

At the institutional level, Ferrum recognizes the importance of undergraduate research and has several programs in place to support it. New faculty members are eligible for New Faculty Grants, which can be used to pay for travel, supplies, and student stipends to support research. Continuing faculty receive travel allocations and can apply for internal research funding through the Faculty Summer Research Grant, Professional Development Fund, Faculty Scholar Program, and Cheatham Fellowship. Students who have completed research projects can receive Ferrum Undergraduate Scholarship Experiences (FUSE!) grants to support travel to present their results at a professional conference.
The second concern typically raised about student-directed research relates to tenure and promotion considerations for faculty. As an undergraduate-only institution, Ferrum values teaching above all other considerations. To further distinguish itself from research-focused “publish or perish” institutions, Ferrum promotes the use of the Boyer model of scholarship, which allows a more diverse approach to scholarly activity than is typical of institutions that promote faculty research (Boyer 1990, Glassick et al. 1997). As a result, student-directed research is often considered of even greater value than traditional faculty-focused research. In the final analysis, it actually benefits the faculty members in the promotion and tenure process rather than hurting them.

Conclusion
The student-directed research model has been successful at providing undergraduate research opportunities at Ferrum College. By cultivating an atmosphere of acceptance and support for nontraditional approaches to undergraduate research, Ferrum has invested in individual student learning, promoted faculty satisfaction and expertise, and improved the curriculum throughout the natural sciences. As the model of student-directed research gains exposure and acceptance, our hope is that funding will become more readily available to support this important application of the well-established, high-impact practice of undergraduate research.

References


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Jason D. Powell earned his BS degree in chemistry, with minors in mathematics and computer science, in 1996 from Virginia Tech. His 2001 PhD work in chemistry at the University of Illinois at Urbana-Champaign focused on synthesis and characterization of oxide nanostructures on metal electrode surfaces. After joining the faculty at Ferrum College, he also earned an MA degree in physics education from the University of Virginia in 2005. Powell has developed several new courses for Ferrum College and focuses the majority of his scholarly work in chemistry on the interests and abilities of his students in a student-directed research program. He is also interested in developing, adapting, and assessing new approaches to teaching and learning in all areas of education. He was appointed as dean of natural sciences and mathematics this year after a one-year appointment as interim dean of the school.

Michaela Gazdik earned her BS degree in biotechnology with a minor in biochemistry from Rutgers University in 2001. She received her MS degree in biomedical sciences in 2003 and her PhD in biomedical sciences in 2007, both from the State University of New York at Albany. Her doctoral work focused on cAMP-mediated gene regulation in the human pathogen Mycobacterium tuberculosis. Gazdik arrived at Ferrum College in 2007 as an assistant professor of molecular biology and this year was appointed biology program coordinator. Since arriving at Ferrum College, Gazdik has started an NIH-funded research program focused on involving undergraduate students in molecular microbial research using the organism Mycobacterium smegmatis. She has also mentored a variety of student-directed research projects and is interested in pedagogical research examining new methodologies to teaching and learning in higher education.

National Conference on Undergraduate Research (NCUR) is an opportunity for more than 3,000 undergraduate students to present their research, scholarly or creative projects.

NCUR 2013 will be held April 11-13, 2013, at the University of Wisconsin LaCrosse.

For more information, visit www.cur.org/ncur_2013.
The mission statement of Southern Illinois University Edwardsville (SIUE) includes five institutional values that our community strives to uphold. The first, citizenship, speaks directly to the issue of environmental stewardship. To this end, the SIUE Sustainability Advisory Group was created in 2008 and consists of students, faculty, and staff directed by the chancellor to “develop a sustainability vision and plan for SIUE that will reduce the University’s ecological footprint, enhance informal and formal sustainability education, and reflect the University’s mission, vision and core values.”

Wisdom, another of our five institutional values, speaks to the “creation, preservation and sharing of knowledge as well as the application of knowledge in a manner that promotes the common good,” according to our mission statement. As part of working toward this value, SIUE’s Undergraduate Research and Creative Activities Program (URCA) encourages students to seek wisdom by getting involved in hands-on research opportunities that take them beyond the classroom, with the ultimate goals being fostering the types of knowledge and skills that professionals in their chosen fields require and making students more competitive in the job market or for graduate education. To better serve a broad range of students, URCA has two levels of participation, associate and assistant.

In the URCA Associate Program, students design their own project (under the guidance of a faculty mentor) and spend an academic year seeing it through from inception to completion. Associates are juniors and seniors who are ready to tackle an issue in their fields more independently than beginning undergraduate researchers. Students apply to the program by submitting a detailed proposal about their intended project, including a timeline and a budget. These proposals are evaluated by the URCA Board, which is made up of SIUE faculty members from many academic disciplines who have a strong history of mentoring undergraduate research. Students who are accepted receive a personal stipend ($2,400), funding for supplies necessary to complete the project ($500), and funding for travel should their research be accepted for presentation at a professional conference ($400). At a cost of $3,300 per URCA associate, these positions are extremely competitive and a typical cohort is made up of only 10 to 25 students per academic year. In addition to completing their research projects, these students also meet monthly for training on topics such as applying to graduate school and creating a professional presentation.

The associates also serve as ambassadors to the university and local community by giving presentations about their projects and the URCA program. They are required to present their work at the annual SIUE Undergraduate Research Symposium. Last year, six of the seven associates in their senior year who applied to graduate school were accepted, giving the group an acceptance rate higher than the reported national average (86 percent versus 29 percent) (Mullen, Goyette and Soares 2003). Of the remaining senior associates who did not apply to graduate school, three of the four had secured jobs in their discipline by the time they graduated.

In the URCA Assistant Program, undergraduates at any academic level are able to work on faculty-led projects for one semester. The assistant program introduces students to the scholarly work that faculty do in the laboratory, studio, or field. There are several key steps in the assistant program. Each academic semester, faculty apply for assistants for their research projects by submitting a form on the URCA website describing their scholarly activity and how they would involve and mentor an undergraduate student or students through the process of their research. Faculty members’ applications are reviewed, and the strongest 100

Former SIUE Chancellor Vaughn Vandegrift and biological sciences professor William Retzlaff pose with students Dan Murphy, Blake Fernando, Roxane Krutsinger, Kelly Thompson, and Mark Ostendorf on the Rendleman Hall.
Assessing the URCA Program

SIUE has clearly invested significant resources in URCA and so routine assessment of the program is necessary to ensure those resources are not wasted. The URCA program underwent significant growth and revision in 2009, including the adoption of a multifaceted assessment strategy. We currently utilize five approaches to assess URCA, ranging from informal, qualitative means to the use of a formal quantitative measure. While a complete review of our assessment plan and the data it has yielded are beyond the scope of this article, we discuss notable findings in two areas:

- **Tracking professional outcomes.** We believe one of the greatest marks of the success of our program is the rate at which our students’ work is accepted in peer-reviewed outlets. For example, in a recent semester, 41 of 149 URCA assistants were co-authors of professional conference posters at venues ranging from the American Chemical Society to the Society for Personality and Social Psychology. Twenty of the 2010-2011 associate class of 22 students presented their work at professional conferences; four of them won awards at their conferences and three have publications “in press.” This suggests that URCA students are doing meaningful work that is valued by professionals in their various fields.

- **Formal program assessment.** Faculty and student participants are asked to complete surveys with items covering such issues as students’ growth as learners and as professionals. Our most recent data suggest substantial growth for students in such areas as the ability to use and understand professional and discipline-specific language, write clearly and effectively in discipline-specific formats, demonstrate intellectual resourcefulness, and offer innovative solutions to problems.

Faculty at SIUE have a wide variety of interests, from social justice issues to human wellness; a significant number of faculty focus on environmental sustainability issues. During the 2011-2012 academic year, 20 percent of the projects of URCA associates and 12 percent of the projects of URCA assistants have fallen under the umbrella of “green” research. This work is being done in a variety of disciplines, including biology, chemistry, engineering, construction, curriculum and instruction, geography, psychology, and sociology. While many of the sustainability projects on campus strive to influence policy changes at the local and state levels or to educate or otherwise influence the population at large, some are structured to provide concrete solutions to defined sustainability issues on campus. These include, for example, installation of a wind turbine and solar panels at the School of Engineering’s Environmental Resources Training Center and new campus construction designed to meet Leadership in Energy and Environmental Design (LEED) certifications. But perhaps no initiative better illustrates the power of undergraduate researchers to become change agents for sustainability than our campus “green roofs.” At SIUE, a green roof is comprised of an engineered system of materials, growth media, and plants that replaces the ecological footprint of the building that was ripped away during construction.

SIUE was established in 1957, and the majority of our buildings were constructed before the end of the 1970s, before environmentally sustainable initiatives were in vogue. Our campus master plan includes a core area of approximately 150 acres of constructed space, surrounded by approximately 2,600 acres of native woodlands, second-growth forest, and reclaimed farmland. Our campus parking lots are fan shaped, with large expanses of impervious surfaces that contribute to storm-water runoff. All campus buildings are limited to three stories by the architectural plan and all have flat, impervious rooftop surfaces. The initial construction arrangement has resulted in some environmental concerns, including management of storm-water runoff on fragile and highly erodible soils. Historically, there were no “green” roofs, not even any white (light-colored, cool) roofs, on the SIUE campus. The rooftops of our campus buildings were dark, flat, hot in the summer, dry, and desert-like. Comprised mostly of black roofing membranes and gravel ballasted roofs, many leaked, and after heavy rain or snow, there frequently was water damage in the building below.

In early April 2004, one of the authors, William Retzlaff in biological sciences, and Susan Morgan in civil engineer-
In 2004, we placed a small green roof on SIUE’s engineering building, and students began research projects. At first, there was one student project with the sole purpose of evaluating plants that would tolerate the hot, dry conditions on the roof. Many other student research projects quickly developed. As academic year 2008-09 progressed, the engineering building’s green roof had expanded to about 1,400 square feet and included eight different research projects—four involving master’s students and four involving undergraduates. The undergraduates’ projects centered on evaluating the performance of the green roof in terms of heat load reduction on the roof surface, plant growth, performance of various growing media for plants, and storm water benefits. URCA assistants collected plant growth and thermal data monthly and collected storm-water runoff data when there was precipitation.

While individual projects differed in their focus, all students were involved in evaluating performance in randomized, replicated experimental studies. Students were led through the scientific process of crafting a hypothesis based on the current literature, designing an experiment, analyzing data, and presenting at professional conferences. The students gained a problem-based, first-hand knowledge of basic sustainability, biological, and environmental principles and became proficient with both field and laboratory techniques. They also worked with a team of industry collaborators who regularly exposed them to new and innovative environmental ideas. In turn, our industry collaborators who worked hand-in-hand with our students were reaping the benefits of being able to substantiate the environmental benefits of various green roof systems through the rigor of replicated scientific experiments. Recent work by two students and one of our industry partners and the National Roofing Contractors Association has now been utilized to establish a wind uplift standard for the construction and placement of green roofs (ANSI/SPRI RP-14. 2010).

In 2009, a new facility, aptly named the Student Success Center, was constructed on the SIUE campus to house academic and personal-support services for students under one roof. When students approved the concept of the new building containing the student success center, it was decided that the building would be “green” and one of those features would be a green roof. In April of 2009, a large group of student, faculty, and staff volunteers planted 20,000 Sedum standard nursery plug plants in a green roof system at an off-site location, and the following August, this newly planted 16,000-square-foot green roof was installed on top of the Student Success Center. This roof provides many environmental benefits to the building and surrounding area, but a
more tangible benefit is that it has become a large research laboratory for URCA students.

The Student Success Center is currently the largest “green” roof on the SIUE campus and is home to five student research projects. In one URCA associate project, student Roxane Krutsinger evaluated the establishment of the Sedum plantings on the green roof. When it is first established, a green roof is typically not fully covered by plant material, so until there is 100 percent coverage by plants, maximum environmental benefits cannot be achieved. By specification guidelines (Philippi 2005), after the first 18 months about 60 percent of a green roof should be covered by plants. Roxane’s project evaluated five methods for increasing the plant coverage; her goal was to find an inexpensive method to increase the roof coverage to more than 60 percent after the first 18 months. Given that the ecological importance of green roof systems had already been reliably demonstrated (e.g., Emilsson and Rolf 2005), Roxane chose to focus her work on reducing the cost of establishing green roofs with the supplemental use of Sedum cuttings—portions of mature plants that can form a new plant in the process known as cloning (Luckett 2009).

Roxane compared the use of Sedum cuttings as a supplement to traditional nursery plug plants. The project could have used more plug plants at a higher cost, but one of the drawbacks of a green roof system is the initial cost to place one on a roof. Over the course of an academic year, Roxane planted three test plots at different locations (east-facing, west-facing, and center) on the green roof; she also spread cuttings on different sections in both spring and fall to determine how the planting season would affect the cuttings. After one growing season, she found that the use of supplemental cuttings increased plant roof coverage, regardless of location or time of planting, indicating that the more economical cuttings were effective in supplementing traditional, but more expensive, plug plants.

Roxane’s findings are of enormous importance to corporate and private building owners who are interested in using green roof technology, but who are put off by the expense of green roofs. Roxane’s work also demonstrates to the owners of such roofs what to do in case of a catastrophic plant failure—rather than replant with expensive plug plants, supplemental (cheaper) cuttings can be used to help recover a lost green roof. Roxane’s work was presented in 2011 at the Green Roofs for Healthy Cities Conference in Philadelphia (Krutsinger et al. 2011). Roxane began working in Retzlaff’s lab as an URCA assistant, then became an URCA associate by organizing and writing her own research proposal, and is now a graduate student in the Department of Biological Sciences working on sustainability conservation in the new SIUE Nature Preserve.

As the green roof on the Student Success Center was being established in 2009, a small patio roof on Rendleman Hall just outside the chancellor’s office was replaced. This roof is comprised of patio pavers in the university’s colors (red and white) with an 880-square-foot “green” roof in the center. The chancellor’s green roof has been the site of several insect biodiversity studies. In one, an undergraduate student under the direction of faculty member Jason Williams has identified numerous species of spiders that inhabit a green roof. In another project, URCA assistant Brittany Buckles is working in collaboration with Retzlaff and a doctoral student, Scott Maclvor from York University in Ontario, Canada, to identify cavity-nesting bees and wasps that might be using green roofs as their surrogate home in an urban ecosystem. Brittany recently applied for an URCA associate position by developing a proposal and expanding her project and submitting it in the 2012-2013 application cycle and was accepted into the associate program this past April.

SIUE is also the home of the Green Roof Environmental Evaluation Network (G.R.E.E.N.), which was established to evaluate the performance of green roofs and green building technologies in the Midwest. When G.R.E.E.N. was started in 2004, SIUE had the one small green roof on the engineering building, which initially housed only a few student research projects. Charged with minimizing the ecological footprint of campus additions and renovations, G.R.E.E.N. currently has 12 green roof projects (including four projects at the Student Success Center) and one living retaining wall project on the SIUE campus. The idea for a living retaining wall is to replace a non-environmentally friendly retaining wall constructed of railroad ties or concrete blocks with a retaining wall that is covered by plants (the same as used on green roofs). Student researchers now have a ground-level field site, as well as roof sites on three core campus buildings, in which to conduct research.

As a result of this expansion, undergraduate research projects have evaluated factors as diverse as the quality and quantity of storm-water runoff, thermal benefits, installation and maintenance of green roof systems, and wind tunnel testing of green roof systems. More than 80 students have worked on G.R.E.E.N. projects at SIUE since 2004, and in the past year faculty and students associated with G.R.E.E.N. have given more than 20 oral and poster presentations, published three peer-reviewed manuscripts, and co-authored a book chapter documenting the benefits of green roofs (Retzlaff et al. 2009) in the seminal book Green Roof Construction and Maintenance by Kelly Luckett. Many of these students were supported through the URCA program, and the contributions of URCA students to G.R.E.E.N. will have helped move SIUE from having one LEED-certifiable (green) building in 2005 to seven in 2014.
The rooftops, parking lots, and landscaped areas around campus represent tremendous opportunity for initiating sustainable projects at other colleges and universities. Using protocols developed by the URCA Program and G.R.E.E.N., other institutions could easily implement projects that would enable campuses to become learning laboratories and symbols of sustainability. Suggestions for implementing such approaches include:

1. Work closely with campus facilities managers. These managers frequently look for opportunities to reduce the cost of infrastructure maintenance and utilities. Often a small pilot research project by an undergraduate can be funded inexpensively but produce a significant outcome if the project demonstrates the opportunity for long-term cost savings.

2. Communicate campus sustainability initiatives. The present movement for going “green” also can be a recruiting tool for ecologically minded students (and parents), as well as local professionals looking to partner with the university.

3. Exploring new ideas for environmental sustainability. A core group of faculty at SIUE was provided with a small stipend from the dean of the College of Arts and Sciences to brainstorm about sustainability initiatives on campus. One result of this “roundtable” was the creation of a campus nature preserve, which serves as both a faculty and undergraduate research tool and a beautiful park for the entire community.

For more information on our campus’s efforts, visit www.siue.edu/urca, www.siue.edu/sustainability, and www.green-siue.com.

References


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Laura Pawlow is an associate professor of psychology and coordinator of the Undergraduate Research and Creative Activities (URCA) program at Southern Illinois University Edwardsville. She received her PhD in clinical psychology from the University of Southern Mississippi and completed both her pre-doctoral internship and post-doctoral fellowship at the Medical University of South Carolina. Her research interests include weight management, gastric bypass surgery, psychoneuroimmunology, and issues regarding the teaching of psychology and assessment of undergraduate research programs. She has published in Biological Psychology, International Journal of Obesity, Applied Psychophysiology and Biofeedback, Surgery for Obesity and Related Diseases, Obesity Research, Training and Education in Professional Psychology, and other journals in the field.

William Retzlaff is currently associate dean of the College of Arts and Sciences at SIUE, professor of biological sciences, and the research co-director of the St. Louis metropolitan area research collaboration (G.R.E.E.N.—Green Roof Environmental Evaluation Network; www.green-siue.com) based at Southern Illinois University Edwardsville (SIUE). He has published in a variety of journals on topics including forestry, air pollution, horticulture, green roofs, and other environmental issues. Retzlaff earned his PhD in forestry with a minor in plant physiology from Clemson University and did postdoctoral work in horticulture (Clemson University), viticulture (University of California-Davis), and environmental sciences (the Boyce Thompson Institute for Plant Research). He also managed the commercial vineyards at Six Mile Creek Vineyards for six years in Ithaca, New York.
Undergraduate Researchers Change Learning and Teaching: A Case Study in Australia and the United Kingdom

Over the last decade, undergraduate research has become a feature of the student experience in many universities across the world. While the primary focus has been on disciplinary research, in some cases universities have championed student research into teaching and learning (e.g. Bovill, Cook-Sather, & Felten, 2011; Burkill, Dunne, Filer & Zandstra, 2009; Healey, Jenkins & Roberts, 2005; Healey, O’Conner & Broadfoot, 2010; Partridge & Sandover, 2010). The opportunity to undertake pedagogic research allows students to develop skills beyond their own disciplines and to contribute to university-wide discussions about changing approaches to learning and teaching. This has meant that student voices have become better informed, adding weight to the role students play in enhancing the quality of institutional academic experiences.

Two universities, at opposite ends of the globe, illustrate this well as both offer undergraduate research programs that allow students to explore a range of institutional issues and to offer recommendations and solutions for academic enhancement and change. The results are being used effectively by the students’ institutions to revise curricula and develop pedagogy.

Dunne and Zandstra (2011) have suggested a range of ways in which students can become active partners in shaping their learning experiences. The model presented in Figure 1 summarizes these and highlights the different roles that students play.

Figure 1: A model of ways in which students can be integrated into educational change
(Source: Dunne and Zandstra 2011, 17)
Students’ involvement in educational change in most universities has largely been at the level of evaluating their academic experience (upper-left quadrant). There are also accumulating examples of students working as partners, co-creators, and experts where the motivational lead has been the staff in the department or university. Where students have taken a more active role, their participation has usually involved engagement in the decision-making processes of committees. However, Burkill et. al (2009) have articulated a more “radical” role for students acting as agents of change (lower-right quadrant) by “setting their own agenda for research on teaching and learning ... engaging with research processes ... implementing their solutions” (87). It should be emphasized that the quadrants in Figure 1 are only examples; student engagement may cut across all of the quadrants in particular circumstances.

In general, the model is underpinned by a growing concern in the United Kingdom about seeing students as customers or consumers, a concept that has long been discussed in the USA, but is comparatively new elsewhere. The idea is controversial because, “If students are envisioned only or primarily as consumers, then educators assume the role of pandeers, devoted more to immediate satisfaction than to offering the challenge of intellectual independence,” (Schwartzman 1995, 220). Furedi (2009) claims: “... encouraging students to think of themselves as customers has fostered a mood in which education is regarded as a commodity that must represent value for money.”

However, new metaphors provide a more positive set of concepts such as co-production, collaboration, and partnership. For example, co-production is perceived as requiring active engagement with the entire learning process on the part of the student, and sees the student as an active participant (McCulloch 2009). Ramsden (2009, 16) envisions students as “responsible partners who are able to take ownership of quality enhancement with staff and engage with them in dialogue about improving assessment, curriculum and teaching.” It should be noted that work in elementary and secondary education is more generally advanced in this arena, with a strong literature regarding the student voice (Czerniawski and Kidd 2011; Fielding and Bragg 2010; Ruddock and McIntyre 2007; Fielding 2001).

This paper presents two case studies, one in an Australian university and the other in the United Kingdom, in which students’ efforts have largely been located in the “agents for change” domain of the model in Figure 1. The University of Western Australia (UWA) and the University of Exeter programs are breaking new ground in providing students, as stakeholders within their respective institutions, with the opportunity to be involved in researching the need for changes in teaching and learning. Both examples provide a wealth of evidence to suggest that these activities are successful in engaging students in researching and implementing new processes in postsecondary teaching and learning. The processes involved have been carefully developed and have the potential to be transferred widely to other institutions.

**CASE STUDY I**

**An Authentic Research Experience at the University of Western Australia**

The Undergraduate Learning and Teaching Internship Scheme (ULTRIS, see website, 2012)) was established at The University of Western Australia in 2008. Undergraduates in their second or third year of study are eligible to apply for the internships. Between 10 and 15 students were selected from each academic faculty, in both 2009 and 2010. The program, which runs for six months, is not for credit but each student is provided a $3,000 stipend to eliminate the need for outside employment. The guiding principle of the program is to give undergraduates an authentic research experience within a well-supported and scaffolded program. The program develops research skills in students that they can easily transfer to their ongoing disciplinary studies. It also allows them to see what advanced research would be like.

In each cohort of interns, a topic identified by the university as a priority issue in teaching and learning was used as the focus of the students’ research. Specifically, in 2009 the focus of research was on “staff/student interaction outside the classroom,” and in 2010, “the first year experience” was explored. The interns are allocated a supervisor and attend an intensive training period in basic research methods at the beginning and throughout the semester-long program. The students develop their own research questions under the umbrella topic that is relevant to their own faculty or relevant to a wider group within the university (for example, rural students, students with disabilities, international students). They then proceed to plan their research, collect and analyze data, write an academic paper, and report their findings within the university community and at an external teaching and learning conference.

Two rounds of these research internships have been conducted with a total of 25 students completing 23 individual projects. Table 1 provides an example of the range of studies undertaken.
Table 1: Examples of Student Undergraduate Research Projects

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<td>Student and Staff Perceptions of Email Expectations and Criteria: What Are They?</td>
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Collectively, the results of the students’ projects each year provide a comprehensive and contextually relevant insight into a particular issue of strategic importance to the university. Individual groups around the university are able to take the findings and use them in development of resources or in revision of practice.

Outcomes for Students, the Institution

At an individual level, students report substantial development of their personal knowledge, skills, and attitudes. For example, all interns point to the gains they have made in communication skills. In the words of one student:

I have learnt ... independent research; collaboration with others—discussing my ideas; public speaking—presenting to a group (on the spot!); the nature of researching—learning to think ahead, trying to cover all options; that is, looking at both the big picture and the small details and trying to integrate them.

All students spoke about the transferability of skills and that their studies in various disciplines had benefited from the research experience. One student said:

I learnt ... how relevant educational research is for all disciplines. That it is useful for improving my own unique experience both through self-reflection on what is useful to me as a student and through being able to critically analyze the institution that I’m supposed to be learning through.

From an institutional perspective, the university has gained through enhanced student engagement. Students reported an increase in interaction with the university as a whole, with staff, and with fellow students across the institution. Noted one intern:

I am a better student because of ULTRIS. I am more involved in my own faculty, my confidence has overwhelmingly increased, and I feel more involved in the “university experience” overall.

Added another:

I no longer view staff as talking heads but as people who would potentially affect the way in which I see the world with their knowledge and experience.

In addition, because the students were all researching a common topic and the area was familiar to them (they all had acquired knowledge and opinions and experiences on these topics by virtue of being students), they had a stake in the process. They became a community of learners sharing ideas and driving the program (instead of being researchers of 15 discrete, unrelated projects). Said one student:

[Having the ability to go out and find what the perceptions and experiences of other students are and being able to get them out to a broader audience is very empowering.

One year the combined results of all the student research projects gave a snapshot—through the student voice—of first-year students’ experience at the university. This snapshot included what that experience was like for rural and international students and covered issues relevant for students from each faculty. It told their stories and incorporated their suggestions for change. It also covered the staff perspective. This snapshot was published as a pamphlet for inclusion in staff-induction kits and teacher-training modules.

Other information from the projects was provided through pamphlets to all faculty members, university and faculty committees, and at workshops and in various publications. It included, for example, information from a student’s study of email communications that provided tips for students and staff on how to get the most from such communications.

The student voice was also heard through the individual achievements of the researchers. For example, those involved in the program were more likely to apply for federal internships, scholarships, university positions, and roles on faculty/school committees. Almost all interns have applied for honors programs or a further degree. As one student said:

I was quite intimidated by the idea of doing Honours because I didn’t have much experience with research, but now I feel really excited to start...
my Honours project, and I feel as though I have the skills to do so.

Hence participation in the internship program has developed skills and attitudes in students that promote change both in themselves and within organizations.

During 2011, the program was rewritten and adapted for two innovative undergraduate research programs. It has been embedded in the new bachelor of philosophy degree, the flagship of a program of new academic courses at the university that began this past February and is the primary training unit for a large group of first year students who have won scholarships. This is a significant departure from the original ULTRIS structure of non-credit, short-term research internships. The primary aim of the new approach is to develop in the new students, from day one of their university life, skills in “thinking like a researcher.” The original internship model has also been adapted for a global classroom within an international partnership among The University of Western Australia, the University of Durham in the United Kingdom, the University of Otago in New Zealand, and Queens University in Canada. Recruitment of students commenced this past April.

CASE STUDY 2
Students as Change Agents: the University of Exeter

The Students as Change Agents initiative at the University of Exeter (see Change Agents website, 2012) is in many ways similar to the work at the University of Western Australia. The focus is on researching pedagogy and curriculum delivery, with students identifying a variety of actions and activities they would like to see implemented, and conducting research to provide evidence for the value of such changes or the direction these changes should take. Projects are akin to action research; students not only develop their expertise in pedagogic research but also take responsibility for trying to bring about evidence-informed change (as outlined in the “Students as Agents for Change” quadrant of Figure 1), promoting reflection and review at departmental and institutional levels. As Janice Kay, the senior deputy vice chancellor for education at Exeter, has said: “We seek to engage students as partners in shaping and leading their own educational experiences through our successful and growing Students as Change Agents initiative. The key concept is that students themselves take responsibility for bringing about change, based on their own research on aspects of learning and teaching.” (Kay et al. 2009)

The initiative enables students to act as responsible leaders and partners, collaborating to improve learning and teaching. Over three years, more than 30 small-scale projects have involved undergraduates looking at topics such as assessment and feedback, engagement in lectures, seminar provision, technology development, learning spaces, employability, sustainability, personal and peer-tutoring, and academic writing. Topics for projects are always decided by students and staff in partnership. Students then act as apprentice researchers, developing a research question, designing and implementing their own methods of data collection and analysis, making evidence-based recommendations or providing solutions for change, and, where appropriate, putting their projects into action. Through the research process, staff act as mentors, with students largely working independently; once evidence has been gained and recommendations made, the approach to bringing about change may become more collaborative, although students maintain a leadership role.

As a more detailed example, students in biosciences identified through a survey that the majority of first- and second-year students struggled with academic writing. They had writing-support sessions led by academics, but these did not come across as tailored sensitively enough for their needs. A small group of students decided to interview staff and students about the exact nature of the writing problems and how the situation might be improved. With this information they produced a detailed guide, “written by students for students,” to academic writing (Bittante et. al 2009). The highly professional-looking guide is available online both locally and for the national biosciences community, and it has been given to first-year students in paper form for two years. The feedback has been extremely positive.

A student-led research project in the business school, where staff members have been piloting a range of technologies, also has had significant impact. Research findings from a student-designed survey and student-led focus groups and interviews highlighted, for example, that three quarters of the 207 student respondents made use of video recordings of their lectures when they had difficulties with understanding content. More than half of the respondents indicated that this was an integral part of their revision process prior to examinations, and international students used recordings for learning in the discipline. Students also thought that using an electronic voting system, used for testing knowledge and understanding, kept them focused in lectures, and they appreciated the interactivity it allowed. Such findings have enabled the business school’s staff to be confident in pushing strongly for further use of technology to help students learn. Streamed video is now far more widespread, and 4,000 voting handsets have been distributed to students to take to all classes while studying for their degrees. The drive for educational technology cannot be said to be due entirely to the Change Agents project, but it has played an
important part in promoting change by providing research evidence.

Feedback consistently highlights the students’ interest in and excitement about their research, the power they feel that research gives them, and the importance of evidence. As one said:

[The interest comes from] conducting real research into what students actually think and being able to present this information to senior staff in full knowledge that what you’re saying is backed up by proof.

As another put it:

Interpreting the results that we got back from the questionnaire was probably the most interesting part [and] contrasted to what I had previously thought.

Students also liked bringing about real change at the institutional level. As one said:

I think the most exciting part of this project has been to see that it is possible to make a change even at such a large institution. Before this project I did not expect it to be possible to make a change, but this has shown me that with a little work and dedication you can make things happen.

Equally important, however, is the influence that the project had on an individual, and on personal growth, reflected in one student’s comment:

This project completely changed how I think.

Also of importance is feedback from academic staff members, who can use the student research as evidence of the need for change and more sensitivity to student needs. Said one staff member:

The Students as Agents of Change initiative has revolutionized the way in which we develop tools for learning and teaching and is an excellent way of embedding student involvement through the curriculum.

A report is written in each of the projects to provide a series of case studies and, to date, three student-led annual conferences have shared findings from the projects with staff and students across the university. In addition Students as Change Agents was the theme for the university’s annual Learning and Teaching Conference in 2011, helping to cement and embed the concept across the institution, with all concurrent sessions being led by students and an accompanying mentor. The influence of the project continues to grow, enabling the university to respond to aspects of learning and teaching that are of most importance to students.

**Discussion**

What is apparent from both studies is the importance of the student voice being actively promoted; students in both contexts come up with their own questions and issues to research, and they engage deeply with the research processes. The benefits to the students from being involved in this way were significant in both contexts: Students were excited, took responsibility, and benefited greatly in terms of their own development, acquisition of transferable skills, and growing confidence.

Both initiatives allow students to undertake research on learning and teaching either as part of, or beyond, their degree programs. Students recognize that they will be supported in research processes by expert supervisors or mentors. This research concept with the student voice at its heart is fundamental to the conceptualization of both initiatives and becomes a powerful driver. Students show commitment to research, and the skills and knowledge they gain give them greater confidence and interest in their university study and career choices. At Exeter, a number of participants reported changing their career pathway because of their involvement, with several deciding to continue with research within their education or employment.

Students at Western Australia report increased engagement with the university, the staff, and their fellow students as a consequence of conducting research into teaching and learning. It seems that this is because the students are all researching a common topic and are working in an area with which they are all familiar—teaching and learning is common to all, particularly the first-year experience. They become a community of learners sharing ideas, empowered through community engagement, and driving the program with a common voice. Similarly, Exeter is working deliberately and explicitly to develop ways of working that will support a widespread ethos of collaborative enterprise, with a community of learners who care about their institution and have the opportunities to be deeply involved with improvement of the learning and teaching environment.

Both models provide the potential for institutional learning and reflection, offering their institutions deeper understanding of student needs and interests, and providing real opportunities for them to enhance their students’ academic experiences. The impact of that research and how it can be applied to enable changes and enhancement in institutional practice and improved curricula and pedagogy are the specific emphases at Exeter.

Many questions remain, for example, to what extent student-led initiatives really can bring about fundamental change and support student satisfaction on a wide scale; to what extent this kind of involvement can become transformational, with student engagement taking on powerful new
meanings; and to what extent the collaborative emphasis can help to counteract some of the more negative aspects of consumerism and the more strident student demands that may continue to characterize the future of higher education. Both initiatives demonstrate the potential of:

- involving students in research on learning and teaching,
- listening to the student voice in new ways,
- putting students at the center of their educational experiences,
- actively engaging them in what matters to them,
- empowering them in their learning and career choices, and
- offering an opportunity for important institutional learning and possibilities for promoting change.

Both initiatives have been carefully conceived to fit their particular context, but either program could be adapted to suit alternative purposes and institutions across the globe. These adaptations are not without challenges, many relating to the variations and complexities in university cultures and approaches to teaching and learning. Some key factors that any institution wishing to take on this kind of project should consider are:

- having a coherent philosophy and belief that students can be involved in more active engagement with the university as decision-makers, and even drivers of change;
- having structures such as a course or program so that students know how to become engaged in such activity;
- providing funding for student payments or, as at Exeter, for a project co-ordinator, since all student involvement is voluntary;
- having staff expertise to engage students in the discourse and professional ways of working in a pedagogic community, as well as support for mentoring;
- providing incentives, whether through payment or, as is even more important at Exeter since there is no payment, gaining recognition and praise, having a higher campus profile and being known by others; being involved in decision-making with peers and experts; seeing real change take place; taking ownership and responsibility for research; or gaining leadership skills that expand student participants’ resumes;
- planning for sustainability. At Exeter, for example, the initiative is expected to expand through its six colleges, with those units taking greater responsibility and ownership.

Of key importance is that students recognize that their voices matter, that their views will be heeded by program leaders or senior institutional managers, and that their work can have an influence on the experience of their peers, on understanding the institution, and on enhancing the learning and teaching environment for all involved.

**References**


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Elisabeth Dunne is head of project development within education enhancement at the University of Exeter, in the south west of England. Her career has been devoted to the promotion of innovation, change and strategic development in education. She has coordinated and directed many major research, development and evaluation projects on aspects of learning and teaching of national interest. In addition, she has promoted a range of ground-breaking initiatives across the University of Exeter. A major focus has always been on the student experience, as well as on understanding the processes of change, including the development of evidence-based practice and working with students as change agents.

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Congratulations to the CUR Quarterly Editorial Team.
They were named the 2012 Committee of the Year at the CUR Annual Business Meeting at the College of New Jersey in June.
A Circular Model for Framing the Undergraduate Research Experience

Sebastian van Delden, University of South Carolina Upstate

Instead of the traditional linear progression of undergraduate education, in which freshman-level coursework leads to senior-level coursework, undergraduate research can introduce a circular approach to education—in which freshmen cohorts of observers interact with senior cohorts of presenters. Along with this concept of undergraduate research, I will also outline how a research support office, center, or person can facilitate this model during a student’s four-year college experience. An “extended” circular model is also possible, in which support personnel can have an impact on a student’s undergraduate research experience before the student enters college and after graduation. This is a generic model that can be applied at any institution of higher education developing an undergraduate research program.

This model is presented against the backdrop of a significant literature supporting the benefits of undergraduate research (Lopatto 2010; Brakke et al. 2009; Landrum and Nelsen 2002). Undergraduates gain improved reading, writing, collaborating, problem solving, and presentation skills, as well as enhanced resumes for applying to graduate school, through conducting and presenting undergraduate research, scholarship, or creative projects. Ideally, faculty mentors of undergraduate researchers benefit as well, because they gain competent understudies who contribute to their scholarly productivity.

Although there are some challenges to achieving the ideal undergraduate research collaboration (Wenderholm 2004), Whiteside et al. (2007) and Coker and Davies (2006) both provide effective and concise guides for selecting and supervising undergraduate research assistants. A faculty member must carefully choose as a research assistant someone who is academically gifted and reliable but also is energetically interested in the research project. Furthermore, the faculty member must have a concise and precisely defined research agenda for the student since the undergraduate’s window for conducting research is typically only one semester or one year.

Every academic institution needs to establish an appropriate balance of support for undergraduate research. Colleges and universities highly interested in supporting undergraduate research will offer internal funding programs, assist faculty in applying for external funding for undergraduate researchers, and coordinate dissemination of research outcomes and collaboration-building events and publications. Stocks (2008) provides a very helpful and succinct overview of the different dimensions of undergraduate research. Numerous papers in the literature also offer a variety of examples of how undergraduate research programs have been established at specific institutions and in particular disciplines—for example, statistics education (Rusell 2010), computer science (Saacks-Giguette and R. Lang 1999), physiology (Randall et al. 2004), engineering (Abdel-Qader 2004), and economics (Borg et al. 2011). In addition, the Council on Undergraduate Research (CUR, http://www.cur.org) has recently published entire journal editions and books that address undergraduate research issues at community colleges (Ceja and Hensel 2009), primarily undergraduate institutions (Karakstis and Hensel 2010), and research-oriented universities (Coleman 2005), as well as addressing issues in specific disciplines, including business (Kinkead 2011), science (Lopatto 2009), literature (Behling 2010), study abroad (Bolen and Martin 2010), and mathematics (Adams 2007).

The Circular Model

The circular undergraduate research model can be demonstrated by a simple and graphic approach to visualizing how undergraduate research can transform undergraduate education. Examples of how this model are now being used at the University of South Carolina Upstate, a public, primarily undergraduate university of about 5,500 students.

Figure 1 illustrates the traditional undergraduate education experience. Incoming cohorts enroll in freshman-level coursework leading to senior coursework.
courses, which cover prerequisite material that students need to master to be successful in subsequent courses, which eventually lead to graduation. The traditional model is a linear approach to education that is intuitive and easily implemented.

The circular model shown in Figure 2 is by design a simple, intuitive, and visual approach to illustrating the undergraduate research experience. It can be used as the baseline to establish an undergraduate research program at any institution of higher education. The model encourages students at all levels (freshmen, sophomores, juniors, and seniors) to participate in the undergraduate research experience. The circular model is divided into three primary phases that often overlap: dissemination, preparation, and research. Students enter and exit the model in the dissemination phase. Ideally, students enter the dissemination phase as early as possible in their college careers, preferably as freshmen. After the freshman year, students transition into the preparation phase, which consists of taking prerequisite coursework and/or engaging in other activities to prepare themselves for conducting research with a faculty member. This phase will take at least one semester, after which the student is ready to transition to the final phase—conducting the research project. At the end of this phase, the student prepares to contribute to the dissemination phase and completes the cycle.

**The Dissemination Phase**

Depending on the size of the institution, dissemination events or publications are coordinated by individual departments or by a campus-wide undergraduate research center or office. Typically, most institutions interested in undergraduate research will have an annual symposium or other event that disseminates the student work completed during an academic year. Less frequently, the institution will also produce an undergraduate research journal that further disseminates well-developed papers based on the students’ work.

The annual event is the lynchpin in our circular model of undergraduate research. During the freshman year, students enter the circular model by participating as observers in the undergraduate research dissemination events and/or readers of publications that are provided by the institution. The benefits of this early participation are multifaceted:

- Freshmen have the opportunity to interact with sophomores, juniors, and seniors.
- Freshmen have the opportunity to learn about the active research projects in their departments. For undeclared majors, this exposure could direct the students’ academic future.
- Faculty members have an opportunity to highlight their active projects to potential research assistants.
- Sophomores, juniors, and seniors have the opportunity to attract new students to extra-curricular academic events, clubs, and organizations related to their fields of study.

To explain how each phase of the model is implemented, we outline how the phase is being realized at our particular institution. The University of South Carolina Upstate holds an annual research symposium in the spring semester and publishes an undergraduate research journal every fall semester. The symposium has been held for the last seven years, and four volumes of the journal have been published. The symposium and the journal are purposely separated so as not to confuse faculty and students with two solicitations for papers/presentations in one semester, and also, more importantly, so that students submitting short papers to the symposium can be invited to submit an extended version of their papers to the journal. This system produces a regular flow of submissions to the journal.

The symposium was originally an internal event, but four years ago other colleges and universities in the area were encouraged to participate. Now, approximately twelve colleges and universities participate regularly in this event, which is currently held at a non-academic, private research corporation in the region. The symposium has evolved in several other ways as well:

- Private industries in the area sponsor the event, and participating colleges and universities are encouraged...
to become contributing sponsors. This financial support allows the event to be free to all faculty, students, and community representatives.

- Besides university students, high-school and community-college students also participate. This establishes a pipeline of gifted students who are constantly learning about research at “the next level.”

- A partnership was developed with the “University 101” program, which offers first-time freshmen a course that helps them adjust to the college environment. All students taking this college-transition course are invited to attend the symposium, which contributes to a steady stream of freshmen observers entering the circular undergraduate research model.

- All academic disciplines are encouraged to have their students participate: science, humanities, the arts, etc. For the arts, pieces of creative writing are read and dance ensembles perform. Further, in a competition leading up to the event, art students submit potential covers for the symposium proceedings. The winning cover is revealed on the day of the event.

To gauge the efficacy of the circular model concept, an online survey was emailed to faculty members and students who attended the last meeting of the symposium (approximately 250 attendees). A total of 80 faculty members and students from ten different institutions, including four-year public and private universities, two-year colleges, and high schools, completed these post-symposium online surveys. We are confident that the completed surveys represent in broad terms the sentiments of the attendees. The faculty members’ survey included the following statements. The respondents had to indicate how strongly they agreed or disagreed with each statement.

(F1) The Annual Research Symposium is a vital part of the Undergraduate Research Experience.

(F2) The Annual Research Symposium has benefited my research assistant.

(F3) The Annual Research Symposium has helped me recruit new research assistants.

(F4) The Annual Research Symposium has benefited my scholarly efforts in some way.

The results of this survey are reported in Figure 3. Faculty members overwhelmingly strongly agreed with F1, which supports having an annual symposium as the focal point of the circular model. Faculty members overwhelmingly also agreed or strongly agreed that their research assistants benefited from the event (F2). Most importantly, the majority of faculty respondents agreed or strongly agreed that the event helped them recruit new research assistants (F3). F2 and F3 provide clear evidence to support the thrust of the circular model—freshmen observers interact with junior/senior presenters and faculty members, which stimulates a perpetual cycle of research assistants. Also notable was that an overwhelming number of faculty respondents agreed or strongly agreed that such an event benefits their own scholarly efforts (F4).

The student survey included the following statements. The respondents had to indicate how strongly they agreed or disagreed with each statement.

(S1) The Annual Research Symposium gave me an opportunity to interact with faculty members and learn about their research.

(S2) The Annual Research Symposium gave me an opportunity to interact with other students and learn about their research project.

(S3) The Annual Research Symposium benefited me.

(S4) The Annual Research Symposium made me interested in doing research.

The results are shown in Figure 4. Most student respondents either agreed or strongly agreed that the event benefited them and made them interested in doing research (S3 and S4). More importantly for our purposes, S1 and in particular S2 provide strong evidence to support the circular model.
in which student observers interact with student presenters, which perpetuates a continuous cycle of undergraduate researchers.

An undergraduate research journal is the other leg of the dissemination phase implemented at our institution. This publication contains papers reporting on projects involving undergraduate students, as well as a few other miscellaneous items, including a spotlight on alumni who have gone on to complete high-quality research studies after graduating from our institution. The cover is designed by a professional graphic artist each year. Hard copies are distributed to more than one hundred regional high schools so that they can be used as a recruiting tool through highlighting the scholarly projects involving students on our campus.

The 24 student authors who contributed articles to the last two volumes of the journal were sent an online survey, which included the following statements and asked for their responses:

(J1) Contributing an article to the Annual USC Upstate Undergraduate Research Journal was a valuable educational experience.

(J2) The skills I learned while contributing an article to the Annual USC Upstate Undergraduate Research Journal has helped me or will help me get into graduate school or get a job.

(J3) Seeing my article printed in the Annual USC Upstate Undergraduate Research Journal made me feel very proud of my work.

Fifteen of the 24 student authors completed the survey. The results are summarized in Figure 5.

The student respondents were also asked to list the skills that they felt they gained in the publication process. The most common response was “writing skills,” but other common responses included “work ethic,” “time management,” “statistical/data analyses,” and “group collaboration.” These results confirm that the students value this experience very much, making a research journal a noteworthy component of the circular undergraduate research model.

The faculty coauthors of the articles from the last two volumes were also asked to complete an online survey that included the following statements. The respondents had to indicate how strongly they agreed or disagreed with each statement.
The Annual Undergraduate Research Journal is a vital part of the Undergraduate Research Experience.

The Annual Undergraduate Research Journal has benefited my research assistant.

The Annual Undergraduate Research Journal has helped me recruit new research assistants.

The Annual Undergraduate Research Journal has benefited my scholarly efforts in some way.

Of the 24 faculty coauthors, 12 completed the online survey. The results are reported in Figure 6.

The majority of faculty respondents was unsure or disagreed that the journal helped them recruit new research assistants (C3). The C3 results therefore suggest that the journal is not an essential part of the circular model’s primary mission, which is to perpetuate a cycle of research assistants. Most faculty respondents, however, did strongly agree that the annual research journal is important (C1) and benefited their student research assistant (C2).

The Preparation and Research Phases

The preparation phase of the circular model involves students taking relevant coursework or independent studies in order to gain the prerequisite knowledge needed to participate in a research project. Since the students will have been exposed to the types of research available to them during the dissemination (symposium/journal) phase, they will have already identified the particular faculty members who are coordinating projects that capture their interests. The dissemination phase, therefore, serves as an effective springboard for launching the students into the correct prerequisite coursework needed to join a particular faculty member’s research group.

The research phase is straightforward, being the time period during which students actually conduct a research project with a faculty mentor. This period is typically one or two semesters; however, if the circular model is perfectly implemented, students can engage in all three phases three times after their freshman year. During each iteration of the cycle, the student’s participation level could increase each year. This would allow a student to be plugged into a research project early on in his/her academic career and help with the preparation phase so that during later cycles he or she is ready to work more independently. Repeating the cycle promotes research groups of students with a range of competence levels and will foster internal peer-to-peer student mentoring as well.

Even though the preparation phase will take the student just as long as the research phase, from the point of view of administrative research support, there is little burden. The coordinator of research support in some cases can act as a liaison between the student and the potential faculty research mentor, guiding the student’s course selection. In cases in which the student has missed the dissemination phase, the research support staff could help the student identify a potential research mentor. Identifying a research mentor is one of the stumbling blocks students face and typically should be mitigated by the initial dissemination phase of the cycle.

Implementing the research phase can vary greatly from institution to institution. In particular, internal funding and financial support of research-support personnel will vary significantly. At my institution, academic affairs provides financial support to employ a part-time director of undergraduate research and provides funds for student travel, research materials, and research assistantships. Sixty-one research assistantships have been funded over the past five years—approximately a dozen students per year. Each student is paid a fixed stipend per semester to assist a faculty member in a research project. All student application processes, including details of the proposed budget, are kept as simple as possible.

To supplement internal funding, the director of undergraduate research collaborates with the university’s advancement office to solicit funds from private companies in the area. We have had particular success in attracting private organizations to sponsor the dissemination phase of the circular model because companies see a tangible return on their investment in funding high-profile events and publications.

To gauge which phase of the circular model most interested students, they were asked which aspects of the research process they enjoyed:
Figure 7. Student Survey Results Regarding Interest in Each Phase of Research

(P1) Studying the background material that I needed to the research
(P2) Conducting the research itself
(P3) Sharing my work with my fellow students
(P4) Participating in the annual symposium (if applicable)
(P5) Writing the Journal article

The results are summarized in Figure 7. It is interesting to note that, even though most respondents agreed or strongly agreed that they liked all parts of the research process, the results were more positive for P1 and P2 versus P3, P4, and P5. This indicates that the students enjoyed learning about the research and actually doing the project more than the dissemination-related phases of the cycle. Budding undergraduate researchers may not realize that dissemination is an important part of the research cycle. The importance of the circular undergraduate research model is further strengthened by these results, since the dissemination phase is strategically placed at both the beginning and end of the model.

The Extended Circular Model

An extended version of the circular model for framing undergraduate research is introduced in Figure 8. The concept involves a recruiting phase prior to the four-year undergraduate education and a tracking phase afterwards.

These extended phases are quite self-explanatory: The recruiting phase seeks to draw college-bound students into undergraduate research, and the tracking phase seeks to monitor the educational outcomes for alumni. Tracking outcomes is particularly important for gathering quantitative data that support the benefits of the undergraduate research experience.

A great recruiting tool is a YouTube Channel that features short, professionally edited videos of undergraduate research projects at the institution. At our university the following channel was established: http://www.youtube.com/USCUpstateResearch/. Seven videos have been uploaded, and at this writing, the videos have received 4,739 views during a little more than a year.

Figure 8. The Extended Circular Undergraduate Research Model
The success of this endeavor far exceeded our expectations; however, there are challenges in creating such videos:

- Professional video recording equipment, lighting, software, and video editing expertise are needed.
- Each of our videos (which range from two to four minutes) took hours of filming and editing to produce.
- The b-roll footage that is edited into the video is filmed as the student actually performs the work. The videographer has to carefully navigate around the research activities in order to not intrude on the research project itself.
- In our experience, few students are keen to take part in this video production, so recruitment of willing participants can be challenging.

Figure 9 shows a “screen capture” of one of the videos as it was being filmed. The student is being interviewed about a piece of art that she created, which is exhibited in the gallery in the background. Three cameras were filming every moment from different angles; special lightening and a boom microphone are being used; and a crew of three people is filming and producing the video. B-roll footage of the student engaged in the project was taken by one videographer at a different time.

During the tracking phase of the extended circular model, Facebook, Twitter, and other social networking sites can help monitor the long-term educational and career outcomes of alumni who conducted undergraduate research. The director of undergraduate research collaborates with the alumni office to support these efforts. Our annual research journal publishes information on alumni who have become accomplished researchers. This ties the tracking phase to the dissemination phase and further encourages freshmen research observers to pursue the research experience themselves.

**Conclusion**

It is clear that the undergraduate research phenomenon is not a passing fad. Around the nation, many colleges and universities are implementing undergraduate research or ramping up their existing programs. The simple visual framework encapsulating the undergraduate research experience that I’ve described can assist any higher education institution in this effort. An annual research symposium that facilitates senior student presenters and faculty members interacting with freshmen student observers serves as both the entrance and exit to this model. The model’s efficacy was supported by assessment surveys after my institution’s latest annual symposium.
References


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Sebastian van Delden is associate professor of computer science and has been a director of the Office of Sponsored Awards and Research Support at the University of South Carolina Upstate since 2007. In the latter role, he has introduced several new internal funding programs for both faculty and students, an undergraduate research journal, a “year-in-review” publication highlighting faculty research accomplishments, a YouTube research channel, and other initiatives. Van Delden teaches computer science courses, maintains an active robotics research laboratory, and has published several peer-reviewed research papers with student co-authors. He won the Annual USC Upstate Teacher of the Year Award in 2011, the Annual Researcher of the Year Award in 2007, and the Vice Chancellor Leadership Award in 2007.
Engaging Student Voices in the Study of Teaching and Learning

Reviewed by Amelia J. Ahern-Rindell, University of Portland, ahernrin@up.edu

In keeping with the theme of this CURQ issue, Students as Undergraduate Change Agents, I thought it would be appropriate to review a book that was co-edited by a faculty-student team about students being invited to partner with faculty to explore the teaching and learning process. In addition, eight of the eleven chapters of the book I choose were co-authored by faculty-student collaborations. In the past, I have been a participant in conversations about the Scholarship of Teaching and Learning (SoTL), and its appropriate inclusion as scholarship in tenure and promotion decisions, but I hadn’t realized how I was actively participating in SoTL practices until I read this book.

For many years now, in addition to utilizing student evaluations to redesign my courses, I have queried my student research collaborators about their perspectives on whether various class activities were valuable learning. Those are experiences. These conversations were, for the most part, informal and occurred while we were working together in the laboratory. This was usually during down time when we were conducting a routine, multistep protocol. On several occasions, I also worked with a few of my more senior students to design problem sets and hands-on activities that I incorporated into coursework for majors and non-majors. However, in my naïvete, I only scratched the surface of how faculty can more collaboratively engage students in the design and organization of courses. This faculty-student partnering decentralizes the power in the classroom and in turn, gives students more responsibility for their own learning and that of their peers. After all, how can we so-called “educators” leave out the most important voices in the learning process? The voices of our students.

Engaging Student Voices in the Study of Teaching and Learning is a guide to how disciplinary scholarship with students can be sophisticated and used to promote learner autonomy. The editors point out that many a faculty has the misconception that students can’t do research and if they do, it is considered “pretend scholarship, more of an exercise in skill building than creating new knowledge.” However, when faculty and students partner together in scholarship “an incredibly transformative student learning experience” occurs. The faculty member benefits from including the student’s perspective with different questions being asked, and different language and analyses used. The student gains “a greater sense of connection with the institution and a heightened sense of ownership for their education.” Learning is appropriately seen as “a process that allows examination and making meaning from knowledge,” rather than just a transfer of information from teacher to student. This allows the classroom to become a “collaborative learning space” where a “richer inquiry into teaching and learning” can take place and students function as “democratic citizens” with an equal sharing of power. Learning becomes what students do, “rather than something done to them.”

This book is organized in such a way that the theoretical basis and practical implementation of this type of scholarship is effectively outlined and illustrated. “Foundations,” the first of two parts of the book, covers the conceptual background of why student voices are so important in SoTL. In chapter one, a student co-author summarizes the underlying principle of student engagement and active participation in teaching and learning when he states “how one gathers information matters because the methods ... determine the viability and value of the information gathered.” The second half of the book, “Enactment,” shows how faculty-student partnering can be illustrated through a series of case study summaries. These include examples of curricular design/ redesign, assessment, and establishing course requirements. Various disciplines are highlighted from the humanities to the sciences. One chapter that caught my attention in particular was titled “Capturing Student Learning.” It forced me to consider how students really come to understand and know information and whether I was doing all that I could to facilitate this process. The authors write about an exercise in a first-year chemistry course that documented students working together to try and understand a challenging concept. Four students in the course were videotaped as they worked together to understand the concept of molecular charge distribution. The concept itself was not important, what was enlightening was how the students went about the process of trying to comprehend the concept. Through a series of still images and transcribed dialogue on video, the student participants, their classmates, and the instructor viewed this slowed-down learning process unfold. They all witnessed the struggle the students experienced to reach understanding and how their learning was tentative and meandering instead of fluid and linear. This not only informed the instructor about how students can work together in a group, but how each of the students had unique contributions and strategies that they brought to the effort. The student participants realized how working with one another forced them to explain their thought processes to one another and thus helped them clarify their own thoughts. The classmates of the participants commented on how it demonstrated that learning is a step-by-step process where you make one connection after another that must all fit together and build upon one another. Everyone seemed to benefit from watching and carefully listening as the actual learning process revealed itself.

After having some time to reflect on the contents of this book, I have come to realize that helping my students acquire new knowledge has to be a partnership in the truest sense. Each participant in the process, teacher and student, must know what the other is doing and why. You really have to listen to each other and work together in a scholarly way to promote learning and knowledge acquisition. All the voices must be heard and respected because they are all integral to the personal, yet public, process of how we come to know, and thus learn.
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The CUR Quarterly publishes articles relating to all aspects of undergraduate research that are of interest to a broad readership. Articles regarding the effects of the research experience on the development and subsequent endeavors of students, and how to initiate, support, or sustain undergraduate research programs are appropriate for this journal. The CUR Quarterly is not the appropriate venue for publishing results of undergraduate research.

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