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Students as Change Agents

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Informal Local Research Aids Student and Faculty Learning

Faculty members are often reluctant to assign research in foundational classes or in classes enrolling non-majors. In such contexts, student research might seem like an inefficient way to meet the course's learning outcomes, and it also seems unlikely that the research would contribute usefully to the discipline. However, while it is important that students have opportunities to conduct serious, long-term disciplinary research under faculty mentorship, informal research has a meaningful place in coursework as well.

Both formal research and informal research can be used to help students find answers and make decisions, though formal research includes stronger attention to design, methodology, and statistical analysis in order to offer an original contribution that meets disciplinary standards. Informal research, on the other hand, has lower stakes and is not vetted as thoroughly in terms of design, methodology, or analysis. Further, informal research is not likely to be published in disciplinary journals. Informal research clearly has limitations, but its value should also be recognized.

As Mary B. Shapiro (2010) argues, “even ‘bad’ research may lead students to form good hypotheses” and help students “learn about the scientific method” (48). Indeed, courses that focus not just on content but also on “learning how to learn” are important for meeting 21-century needs, especially as such courses teach students to problem-solve by appropriately collecting and analyzing data (Partridge and Sandover 2010). Additionally, informal research can increase “student engagement, learning, and prosocial attitudes” (Shapiro 2010, 48). In other words, even quick and dirty research can meaningfully support learning as students closely engage the course material and simultaneously develop research skills.

Informal research that focuses on local issues, furthermore, not only helps students to apply course ideas to real-world situations but can also make a difference to the community. Student research in teaching and learning has been conducted by teachers and scholars. Many such studies incorporate student voices, but “until recently, the student involvement in teaching and learning research has been as a source of data for academic investigators, who have ‘listened’ to, and then reported, the student voice” (Partridge and Sandover 2010). Students can have a stronger role, however, “as agents of change” if they are the ones setting the research agenda, implementing it, and publicizing it (Burkhill et al., cited in Partridge and Sandover 2010).

As students conduct such research on a local level, they can “take an active role in shaping their own learning experience,” ultimately leading to student engagement because the work is so clearly relevant (Partridge and Sandover 2010). Importantly, it is not only the students who benefit. The university itself can grow as students “contribute to curriculum design and development” by using experiences and perspectives that “can lead to significant enhancements” in the institution (Campbell et al. 2009, 29). Simply put, local student research in teaching and learning benefits all involved, even when done on a small scale.

It was exactly this sort of research that was conducted by students in a composition theory class I taught at Marywood University in fall 2009. While half of the students were English majors, the rest came from many other disciplines, and the class included sophomores, juniors, and seniors. Furthermore, none of them had been exposed to composition theory before my class, and there was a lot of ground to cover. While such factors could have easily deterred me from assigning research, in this case, I saw an opportunity. As Marywood University’s writing coordinator, I assess and support undergraduate writing, and it made sense that composition-theory students could apply ideas from course readings while finding out potentially useful information about their peers’ writing experiences. My assignment thus asked students to choose a writing topic based on course readings; collect local data; and present their findings on a web page that would be useful for Marywood faculty. While such a study could be a full-blown research project lasting
a semester or more, in this course it was compressed into a week and a half. Still, even this quick informal research helped students meet course outcomes while contributing to university writing initiatives.

Assignment Design & Student Learning

The composition-theory course in which I assigned this project was structured in chronological units that traced major developments in composition research from the 1960s to the present. The project was assigned early in the term to help students become more comfortable with understanding and applying composition scholarship in general; at the same time, it reinforced major themes of early composition theory on which students could build during the rest of the semester. The project thus contributed to learning outcomes aimed at helping students improve in their ability to “identify major trends and arguments in composition studies,” “respond to scholarly texts,” and “talk with others about writing” (McMillan 2009, “ENGL 475”). Specifically, the research project asked students to respond to composition trends in the 1960s and ’70s, especially the foundational research of scholars such as James Kinneavy, Donald Murray, Mina Shaughnessy, and Janet Emig. Each of those scholars theorizes about writing and how writing is best learned and taught, generally beginning with criticism of traditional methods and emphasizing more productive pedagogical approaches.

With this focus on improving the teaching of writing, it made sense for my students to synthesize these course readings by finding out how often the ideas of these key composition scholars were being applied on our campus. Students thus worked in collaborative groups to find out how early research about writing and pedagogy was being enacted on Marywood’s campus, keeping in mind that Marywood faculty would be the audience for their findings.

The whole project was to be completed in just over a week, so we kept it straightforward and simple; yet every step helped students synthesize early composition work in order to see how the theories of teaching and learning writing were (or were not) being applied at our university. To focus the research, students looked back over readings and brainstormed questions that might be investigated on campus. We then compiled a cumulative list of potential research questions on the blackboard that was quite extensive and included items such as:

- How early do students start working on an assignment?
- What kinds of writing are students assigned?
- How often are students required to hand in drafts?
- Do assignment sheets emphasize grammar more than content?
- How much teacher feedback is helpful?
- What kinds of teacher comments are helpful?
- Is peer review useful?

Once we had generated a large number of questions, we clustered the areas of inquiry into four broad categories, and each student group was assigned one of the following categories: 1) students’ experience with writing, 2) students’ assignment preferences, 3) students’ writing processes, and 4) students’ use of feedback. These steps alone—brainstorming questions and forming categories to focus research—helped reinforce the major themes and the relevant theories of early composition research. At the same time, students were using inquiry in ways similar to the composition scholars whom they had been studying.

The next steps required students to use research skills in ways that helped them understand the difficulties compo-
sition researchers regularly face. Students designed their studies in class, with a “Planning Sheet” directing them to first decide on the “three to five questions [related to their category] that seem most interesting and useful to teachers” at our university (McMillan 2009, “Planning”). Once they had focused the scope of their research, they were asked to decide on how they would find the answers, using methods such as “survey or interview, [with] multiple choice or open answers” (McMillan 2009, “Planning”). In a more formal research assignment, this step would have been given more attention, and research designs would have been fully vetted.

However, even this informal approach helped students think about the importance of methodology. For example, one student research group’s web page explains that the group’s “survey was presented to students in the form of an open-ended question” and thus “students were permitted to somewhat elaborate on the question being asked” (Irby et al. 2009). Here, students are justifying their research choices. When they presented data on the number of writing courses students have taken, students in another group noted that one of their questions might have been unclear: “We are unsure of the accuracy of these results because we believe that some surveyed did not realize we meant only writing-specific courses” (Brennan et al. 2009). In this case, students learned not just from their successes but also from their failures. Each time research approaches were explained or results were questioned because of research design, students were demonstrating awareness of methodology and the way it complicates findings. At the same time that students were practicing transferable research skills, they were becoming more familiar with the kinds of questions about methodology that regularly arise in composition scholarship.

Once students focused their research and planned their methods for gathering data, they collected data outside of class, and they communicated their results on web pages set up during a class workshop. Throughout these steps, students faced challenges common to all researchers, such as how to find participants, how to increase validity and reliability, and how to analyze and communicate results. Because the stakes were fairly low, however, students became more aware of the difficulties of conducting strong research studies without necessarily needing to resolve every problem. Students expressed appreciation for the variety of skills involved in research, and working collaboratively helped them recognize both academic and interpersonal attributes that were of value during the research process. These included the ability to write clear questions, talk comfortably to potential participants, create graphs, interpret data, and design a web page. In peer evaluations, students regularly noted such strengths in other members of their groups. Although the research was informal and completed quickly, students still expressed awareness of the skill sets strong scholars need to employ.

Although some students put more effort into the research than others, for the most part students demonstrated their learning as they took on the roles of experts when publishing their findings on their web pages. For example, the group exploring students’ use of teacher feedback said their peers’ response was “exactly the type of response we were hoping for” (“Student Use of Feedback” 2009), almost as if the researchers were not students themselves but instead were aligned with composition scholars. This stance was taken even further on another webpage that concluded by establishing a connection with Janet Emig’s (1977) belief in “Writing as a Mode of Learning”: “Likewise, we want to move writing from just a homework assignment in the Marywood classroom to a focus in the student education” (Brennan et al. 2009). Here, despite the informality of the research, the students framed it with purpose and worth that connected their work to the scholarship they had been reading. In an earlier paragraph on that web page, the students acted as strong advisors to faculty, reminding teachers that “it is imperative for those who are imparting knowledge to be aware of the caliber and degree of experience their pupils possess” (Brennan et al. 2009).

Even though the research process in my assignment was extremely informal, it still helped students recognize themselves as scholars with information that should be shared with others in order to potentially effect change. Indeed, even students who completed only minimal work referred back to the early semester readings and research throughout the rest of the term. Clearly, students’ familiarity with trends in early composition scholarship increased, and they better understood the potentials and limitations of composition research processes as well.
**Applications: Faculty Learning**

While any course assignment needs to first benefit students and their learning, the usefulness of local research helps many students feel invested precisely because they are meeting others’ needs. The student web pages were connected to my composition website in order to be easily accessible to faculty interested in developing their teaching of writing. Furthermore, as writing coordinator at a university that does not have any writing requirement beyond a first-semester composition class, I have been able to use the students’ research as I encourage teachers to assign and support undergraduate writing.

Specifically, I have used the research to a) highlight student experiences in my faculty workshops on writing pedagogy and b) provide supplemental information in an annual Undergraduate Writing Assessment Report, especially when proposing that a requirement for an intensive writing experience for all students be considered by the core curriculum committee. In both these situations, the students’ research has not been a driving force but instead has helpfully supplemented other material with relevant local information.

In workshops with faculty, the students’ research provides information and provokes discussion. For a workshop on designing effective assignments, for example, faculty members discuss sample assignments, and I then introduce the information our Marywood students have published online. One point that faculty often debate is whether students’ writing assignments should stipulate the number of pages required. We turn to the data showing that most students like to know how long an assignment is (Bridger et al. 2009), and we can then have a conversation about it.

Often, the first interpretation of the data is that students are not interested in thinking and learning and instead want a fill-in-the-blank assignment. But once faculty talk about their own writing experiences, they begin to realize that they all normally have a sense of how long publications should be as they work on them, and this knowledge shapes their writing decisions. The student data thus spurs faculty to identify with students’ circumstances.

In that same workshop on designing effective assignments, I also discuss problematic findings from the student researchers’ web pages. For example, a number of Marywood students show resistance to peer review and to workshops on how to use the library (Bridger et al. 2009). While such data could simply lead to faculty omitting these elements from their classrooms, the workshop setting provides an opportunity to discuss how peer review and/or library workshops can be implemented more effectively. Local research—even informal research—thus identifies areas that need faculty attention. As faculty members connect with student experiences and perspectives, we can make better-informed and more thoughtful pedagogical decisions. Ultimately, the students’ research benefits students themselves because it helps faculty improve writing pedagogy in their classrooms.

In addition to using the student research in faculty workshops, I have also included some of the findings in assessment reports. Specifically, I have used information about what kinds of writing students are doing and which disciplines tend to assign writing (Brennan et al. 2009). I gather similar information through other campus surveys and studies, but these measures have generally shown less campus emphasis on writing than the students’ findings, which noted a wide variety of assignments and disciplines in which writing was included (Brennan et al. 2009). This student-driven data has been helpful in the proposal of a writing intensive (WI) core requirement. In order to develop such a requirement, we need a host of classes that could either currently meet WI standards or could be changed slightly in order to fill WI criteria. The research conducted by students helps pinpoint some of the departments that are already supporting undergraduate writing and could thus be leaders in a WI initiative. Just as some of the data were problematic and helped lead to changed teaching practices, other data were positive and have helped inspire and encourage other teachers to follow suit by integrating writing more fully in their courses.

While not every teacher can use student research in an administrative role the way that I have, my experiences do suggest that informal research has a place in academia, because it supports students as active learners and can yield useful information. Especially in courses in which students regularly read academic research in the discipline, it seems important to go beyond having “students learn about research findings,” in order to have “students learn as researchers” (Braber 2011, 3). Research in teaching and learning may be an especially fruitful area for students who
wish to make a difference in their local contexts. Instead of reserving research for semester-long projects, we serve students and one another better if we encourage students to be experts and scholars in small ways on a frequent basis.

References


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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.
Introduction

“It has inspired me to push the limits, to keep asking questions and keep believing we can solve any problem. I have been exposed to many applications that I did not know existed before. I used to think doing research in math was purely proof based. Now I see that research in math has endless possibilities.” This feedback is from one student who participated in a Research Experiences for Undergraduates (REU) program funded by the National Science Foundation (NSF) at George Mason University (GMU) in 2010.

“I am most interested in how mathematics can be used to help people in the real world. With the passing of my uncle, the idea that my (undergraduate) research could some day be used by doctors to help them understand and prevent aneurysms is a very rewarding feeling.” This comment came from another George Mason undergraduate who was funded in part by the NSF Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS) Program and the Undergraduate Apprenticeship Program in the George Mason Honors College in 2010-2011.

Both comments are great illustrations of the impact of exposing undergraduates to research in advanced topics in mathematical sciences that have applications in the real world. Such undergraduate research (UR) programs not only help develop innovative research methods to explain fundamental mechanisms needed to understand quantitative and qualitative behavior underlying scientific and engineering applications; they also can help student researchers become change agents for transforming practice in teaching, research, and education.

According to the Council on Undergraduate Research, “Undergraduate research is an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline” (CUR 2011). Several leading institutions have initiated interdisciplinary programs in UR intended to train individuals in such inquiry-based aspects of problem solving. Students in many institutions across the country are able to use new knowledge acquired through UR to produce new results that have made a difference in the disciplines.

However, a great need still exists for these students to also learn to use their UR experience to become change agents, helping to transform an institution. In other words, to make the research they participated in more meaningful, students must also learn to wear the hat of a change agent, promoting and communicating their UR to a broader community of learners. Such a student transformation will require a systematic approach that involves a lot of mentoring, guidance, and support. This investment can help student researchers become competent enough to create, to facilitate, and to sustain an institutional culture in which peers, graduate students, faculty, and administrators continue to learn and evolve with them.

This article describes the role of undergraduate researchers as change agents who not only help to enhance ongoing interaction among communities of people, including students, educators, and academicians, but who also serve as catalysts to help reinforce and drive reform across an institution. UR in computational mathematics is used as an example because of the author’s expertise in guiding several UR projects in this discipline over the years. However, the concept and approach described can be easily extended to other disciplines and, indeed, to transform teaching and research practices for students and faculty from the high school to the graduate levels. The role of institution and faculty in helping transform students into change agents is described, and specific examples of programs and opportunities at George Mason University are discussed, including one model program that has had cascading effects on student learning.

UR in Computational Mathematics

Undergraduate research in computational mathematics, a field that comprises modeling, analysis, simulation, and computing, is quickly becoming the foundation for solving most complex problems in science and engineering. These real-world problems often involve complicated, dynamic interactions among multiple physical processes, thus presenting significant challenges in representing the physics involved and in handling the resulting behavior. Hence, to
capture the complete nature of the solution to the problem, a “coupled multi-physics” approach is essential.

Performing research and teaching in computational mathematics therefore, require an in-depth understanding of the underlying mathematics and the fundamental principles that govern a physical phenomenon. It is understood that such physical systems can be described by complex partial differential equations that cannot be solved by textbook solutions. Thus, understanding the behavior of the numerical solution to such equations is of paramount importance for elucidating the actual physical problem. Researchers in this field have come to appreciate that analyzing a numerical technique requires a combined theoretical and computational approach. Theory is needed to guide the performance and interpretation of the numerical technique, while computation is necessary to synthesize the results.

The methodology for a solution therefore involves formulating a mathematical model from a physical system and then being able to solve this model using an analytical (exact) approach or a numerical (approximate) approach. The mathematical models developed as a part of the UR are then validated using real experimental data. This problem-solving methodology is illustrated in Figure 1.

The focus of most undergraduate researchers’ projects in computational mathematics is to systematically combine sophisticated mathematical techniques with high-performance computing to develop problem-solving methodologies that are then applied to several computationally challenging problems. These new methodologies not only benefit various scientific and engineering fields, but also aid in the process of designing better products and processes.

**Students As Institutional Change Agents**

Breakthrough research, education, and teaching in UR programs often involve multidisciplinary efforts spanning scientific and engineering disciplines. George Mason University is committed to excellence in this realm by engaging students in UR through a variety of research programs. Some examples of these include the Undergraduate Apprenticeship Program/Undergraduate Research Scholars Program (open to all students); the School of Dance’s Senior Synthesis Presentations (College of Visual and Performing Arts); the Diversity Research Group’s Ethnography of Diversity project (an interdisciplinary project in the Office of University Life); Undergraduate Research in Computational Mathematics (mathematical sciences); the Aspiring Scientists Summer Internship Program (College of Science); and Students as Scholars Program (Center for Teaching Excellence).

While most universities provide such opportunities both within and outside the institution, one of the key problems that many institutions have faced is the lack of communication and coordination of these independent research programs, often making it difficult for students and faculty to know how they can get involved or even know that such programs exist. “If anything is clear from the debate about education, it is that the various levels of formal learning cannot operate in isolation, and that the quality of scholarship surely begins in school, and especially in college—a time when the student’s breadth of knowledge and intellectual habits will be either strengthened or diminished” (Boyer 1990).

One way to improve this is by encouraging students to become change agents and promote students’ awareness that their education means engaging with scholarship and that it is not just about making good grades in their courses. Along with exposure to undergraduate research with a faculty men-
tor, students must be given opportunities by their institutions to engage in collaboration, interdisciplinary work, and creative activities. The skills gained in such activities will help them to become effective change agents—to reach out to other students and to people outside the university community to share the value of their undergraduate research.

This experience will not only help the students gain a deeper understanding of their own research and place it in context, but also will help them acquire important skills in leadership, building group dynamics, and communicating their discipline to both technical and non-technical audiences. As change agents, students will also help faculty transform their practices in undergraduate teaching, research, and education through multidisciplinary efforts—which in turn often have led to new collaborations and open-ended explorations.

Being a change agent is now becoming an integral part of the work of many students and faculty members at George Mason, and this has helped stimulate improved methods for organizing, tracking, and publicizing ongoing activities and projects. GMU also supports the dissemination of the results of UR projects at the institution through several local opportunities, such as the Celebration of Achievements (hosted by the Office of the Provost and the Office of Research & Economic Development); the Undergraduate Research Symposia and Conferences (separate conferences hosted by the College of Science, the College of Humanities and Social Sciences, and the School of Conflict Analysis and Resolution); Juried Undergraduate Exhibitions (the College of Visual and Performing Arts); Aspiring Scientists Summer Internship Program Poster Presentation (the College of Science); and the STEM Accelerator Program (the College of Science).

These local dissemination opportunities have not only helped in the professional development of the students but also have helped them prepare to be better change agents as they disseminate their work beyond campus. Some of the external opportunities have included the CUR Posters on the Hill, the Colonial Academic Alliance’s Undergraduate Research Conference, the undergraduate research conference of the Virginia Collegiate Honor’s Council, the Joint Mathematics Meetings Undergraduate Research and Poster Presentations, and the National Conference on Undergraduate Research (NCUR).

UR also is promoted through university-wide publications that include the George Mason Review, a cross-disciplinary undergraduate journal that publishes exemplary scholarly works from Mason undergraduates; Volition, a magazine that serves as the creative voice of GMU undergraduates; the Hispanic Culture Review, a journal that contributes to GMU’s multiculturalism; and Diversity at Mason, an annual publication of the Diversity Research Group. These publishing venues have helped to disseminate innovative approaches to undergraduate scholarship and created a community of learners who actively acquire additional knowledge.

Mentors, both faculty members and graduate students, are central to the process of UR students’ becoming change agents. Mentors help students master the content necessary to perform research and also help them to transform their understanding of the disciplinary habits of mind. Students can then help promote the faculty’s research and the discipline as a whole to other potential students who may be thinking of careers in the particular field. Graduate students gain the valuable experience of mentoring, and faculty may gain different insights into their work from exposure to undergraduate researchers’ perspectives, since the students begin the work they are assigned without any bias or opinions about what is or is not expected from the research. Such fresh student insights may often open up new research questions or questions overlooked by the current research. Through this scholarly interaction with faculty

Students and faculty working in a group research session.
and graduate students, the undergraduates become change agents who help in furthering the faculty and graduate students’ research programs, their professional development as mentors and educators, and their teaching and pedagogical practices.

The following describes one UR project that has had a cascading effect on student learning, created change agents at various levels of education, and helped to transform the teaching practices of the high-school teachers and faculty involved.

**Multi-Level Change Agents**

A recent undergraduate research project involved mathematical and computational modeling of intracranial saccular aneurysms—thin, membranous balloon-like widening of arterial walls—the rupture of which are the most common causes of bleeding onto the surface of the brain, which results in strokes. Despite advances in neurosurgery, these aneurysms continue to result in significant numbers of deaths. Therefore, predicting the potential of aneurysms to rupture is fundamental to clinical diagnosis and treatment. The UR project helped to develop a very simple mathematical model of a thin-walled, spherical intracranial aneurysm surrounded by cerebral spinal fluid or CSF (See Figure 2). This model involved solving coupled partial differential equations for fluids (modeling blood and cerebral spinal fluid) interacting with elastic structures modeling aneurysms using novel approaches (Venuti and Seshaiyer 2010).

The UR project that gave opportunities to two undergraduate students in their junior year during 2009-2010, was able to validate this model using analytical techniques and computational tools. The mathematical tools developed as a part of this transformative UR project have since been extended to provide better understanding of the mechanics of the rupture of aneurysms. The original findings also were extended to study the dynamic behavior of the aneurysm wall in response to periodic (blood) forces. The project ultimately led to some open-ended questions that evolved into separate summer research projects for two other undergraduates. Not only did the overall UR project lead to new discoveries, but it also went on to receive three national awards for outstanding UR, one at the second annual undergraduate poster session of the Society for Industrial and Applied Mathematics (2009 and 2010). One of the research questions from the UR projects also led to a doctoral thesis, completed recently (Samuelson and Seshaiyer 2011).

**Change Agents In K-12 Outreach**

The computational project involving aneurysms also became a perfect platform for K-12 outreach. In particular, the UR student who worked with the author ended up co-mentoring a high-school teacher during the summer research program. The teacher was able to work on a related aspect of the project and take it back to her school and district to discuss how important, innovative, and useful the UR project was to teaching the high-school curriculum. Not only was the teacher able to use the UR project in her intensive pre-calculus classroom; she also was able to teach a “lesson study” that helped high-school students understand the importance of pursuing mathematics and science.

“Lesson study” originated in Japan and has become widely accepted as an effective form of professional development for teachers (Lewis 2002, 1998). It is based on a research process that includes observation of live classroom lessons taught by a group of teachers/researchers; collection of data on teaching; learning and collaborative analysis; and revision. Although lesson study is becoming popular at the elementary and middle-school levels, there are very few examples of successful lesson studies at the high-school level. In her lesson, the teacher was able to effectively con-

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**Figure 2: An illustration of an aneurysm-arterial wall-CSF interaction**

![Figure 2: An illustration of an aneurysm-arterial wall-CSF interaction](image-url)
Said the teacher, Kris Kappmeyer: “As a high-school teacher, my reasons for participating in the UR Program were to improve my credentials as a professional in the teaching field and to broaden my knowledge base in order to give more current answers to the question, ‘When am I ever going to use this?’ The UR program really gave me a broad survey of the available fields in math and has most definitely enhanced my understanding.” Not only did Kappmeyer enhance her teaching practice by going beyond traditional classroom teaching, but the UR project also helped to enhance students’ learning by incorporating the research component in her presentation.

In fact, Alicia Hamar, one of the students in Kappmeyer’s classroom, was inspired to continue on to work with the author on another aspect of the project. This high-school project won the grand prize in the Northern Virginia Science and Engineering Fair in 2009 and the student was invited to the Intel Science Fair Competitions. This domino effect led to the original UR project, “Mathematical and Computational Modeling of an Intracranial Saccular Aneurysm,” being showcased at the 2010 CUR Posters on the Hill in the mathematics/computer science category. This event gave the original George Mason UR student an opportunity to meet and discuss the importance of UR with several Congressmen and Virginia Senator Mark Warner (see photo).

The same picture with Senator Mark Warner also appeared on page 18 of CUR’s Triennial Report. The highlight of all the ramifications of this project was a letter from the Governor of Virginia’s office commending the contributions that this UR project made to the study of the STEM (science, technology, engineering, and mathematics) fields.

**Change Agents In Faculty Growth**

As a faculty mentor, my involvement in this UR project and several others I have directed has helped me to recognize the importance of integrating teaching and research to improve the effectiveness of teaching and student learning. My goal in directing such UR programs has always been to demonstrate the value of coordinated multidisciplinary research activities and also to provide a realistic setting for the teaching and enhancement of research skills. I have also learned to build sustainability into the UR projects I direct in order to help provide opportunities for students to become change agents by extending their work beyond the classroom.

The report, “Why So Few? Women in Science, Technology, Engineering and Mathematics,” published by the American Association of University Women (AAUW) and funded by a grant from the National Science Foundation, involves a review of literature about gender and science published over the past 15 years. The contributors examined some
of the findings about why women and girls remain under-represented in the fields of science, technology, engineering and mathematics (STEM). One of the contributors, Andresse St. Rose, a research associate at AAUW, wrote “In schools and in homes the environment that is created serves to subtly and perhaps in some cases not so subtly discourage girls or encourage them to focus on other areas, even if they might have a brimming interest and ability in science.”

The UR project described in this article gave research opportunities to five women and two men. They included four undergraduates (three women—one an African-American—and one African-American male); a female high-school student and a female high-school teacher; and a male graduate student. UR is a great way to encourage women and underrepresented minorities to pursue multidisciplinary mathematical careers that bridge the scientific and engineering communities. The author strongly believes that UR is essential for the development of a diverse and well-prepared workforce of scientists, engineers, and educators that is needed to build the infrastructure and knowledge for enhancing STEM learning.

Acknowledgement
The author would like to thank for their work on various aspects of the UR project George Mason undergraduates Minerva S. Venuti, Avis Foster, Courtney Chancellor, and James Halsall; high-school teacher Kris Kappmeyer and high-school student Alicia Hamar; and Dr. Andrew Samuelson, a former graduate student.

References

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Padmanabhan Seshaiyer is currently a tenured professor of mathematical sciences and also the director of COMPLETE (Center for Outreach in Mathematics Professional Learning and Educational Technology) at George Mason University, in Fairfax, Virginia. Over the last decade, Seshaiyer has initiated and directed several undergraduate research, educational outreach and professional enrichment programs to foster the interest of students and teachers in mathematics at all levels. Prior to joining George Mason University in 2007, he was a tenured associate professor of mathematics at Texas Tech University, in Lubbock, Texas.

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.
I am truly honored to have been selected as a CUR Fellow for 2012, and I thank the selection committee for this tremendous privilege. Since learning of this award, I’ve taken the opportunity to reflect on the many individuals, organizations, and circumstances that have supported me in my undergraduate research endeavors. In my mind, three factors have profoundly shaped my undergraduate research journey—my institution, Harvey Mudd College, with its strong culture of undergraduate research; my students over the years who have been passionate about their research; and my long and wonderful association with CUR. I’d like to share a few thoughts about the impact that each of these areas has had in my career.

Tracing the Roots of the Institutional Culture of Undergraduate Research at Harvey Mudd

Harvey Mudd College (HMC) is a young institution, founded in 1957 with a focus on science, engineering, and mathematics. Our founding president, Joseph B. Platt, was the true architect of our strong institutional culture of undergraduate research. In his memoirs looking back at the start of the college (Platt, 1994), he spoke of looking for faculty with strong interests in research and scholarship: “The college was planned as a teaching institution, not a research institute, but I knew from personal experience that research can assist teaching by keeping the faculty interested in new developments and by involving able students with problems for which the answers are not yet known. Hence, I hoped for teachers with continuing interests in research and scholarship.” The faculty he selected did indeed have the determination to conduct research despite the lack of facilities, time, or money in the early days of the college.

If we fast-forward more than 50 years, how has the culture of undergraduate research progressed at the college? One measure of the pervasiveness of the research culture was recently revealed in an alumni survey (HMC Impact Project) conducted in 2009-10 to answer the question: “Is HMC making an impact in the lives of its students?” One of the survey questions specifically asked, “Which skills gained at HMC are most valuable to you now?” Over 26 percent of our alumni responded to this open-ended question, and the responses were analyzed by the frequency of the particular response. The findings indicate that research was the number one skill gained at HMC that was viewed as most valuable to our alumni now (see Figure 1).

Figure 1. Responses to the alumni survey question, “Which skills gained at Harvey Mudd College are most valuable to you now?” with font size reflecting the relative frequency of response.

Clearly a great deal has transpired during those 50+ years to yield this result. Table 1 is a list of what I view as the top ten pivotal moments in the history of undergraduate research at HMC.
Table 1. Top Ten Pivotal Moments in the History of Undergraduate Research at HMC

<table>
<thead>
<tr>
<th>YEAR</th>
<th>PIVOTAL MOMENT</th>
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<tbody>
<tr>
<td>1960</td>
<td>1. Continuous summer research program in chemistry started with NSF-URP funding (now NSF-REU funding)</td>
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<tr>
<td>1961</td>
<td>2. Senior research required for graduation in chemistry for all classes</td>
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<tr>
<td>1980</td>
<td>3. HMC represented in CUR with Professor Mitsuru Kubota as councilor in 2nd year of organization’s existence</td>
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<tr>
<td>1983</td>
<td>4. Beckman Research Endowment received to enable faculty start-up packages and internal research awards</td>
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<tr>
<td>1987</td>
<td>5. College makes commitment to support summer student housing</td>
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<tr>
<td>1991</td>
<td>6. Faculty vote to celebrate student creativity with three-day event, “Presentation Days”</td>
</tr>
<tr>
<td>1994</td>
<td>7. Chemistry department starts sophomore spring-semester research program (and now also offers a research course for first-year students)</td>
</tr>
<tr>
<td>1998</td>
<td>8. Harvey Mudd College receives NSF Award for the Integration of Research and Education</td>
</tr>
<tr>
<td>1999</td>
<td>9. Harvey Mudd College joins CUR as an institutional member (and in 2009 elects enhanced membership)</td>
</tr>
<tr>
<td>1998-2008</td>
<td>10. Harvey Mudd College establishes Research Fellowship Programs in Engineering and receives Stauffer Challenge Grant in Chemistry to provide endowments for undergraduate research</td>
</tr>
</tbody>
</table>

The list could be sorted into three categories. The first category consists of various decisions that a committed faculty made to support undergraduate research (items #1, 2, 6, and 7). In 1960, as soon as we had a science building on campus, the chemistry faculty started a summer research program and that tradition continues today and now involves all departments at the college. With an undergraduate enrollment of 750, we typically have more than 200 students on campus in the summer conducting research in collaboration with faculty. In 1961, with the first senior class at the college, a senior research thesis was required in chemistry; now all graduating seniors in all departments conduct a year-long senior thesis project or participate in an industry-sponsored team clinic. In 1991 the faculty voted to cancel three days of classes at the end of the spring semester for what we call Presentation Days to celebrate students’ research and creative activities. Nothing indicates faculty commitment more than the willingness to forego classes for a few days! Finally, formal efforts to involve students in research well before their senior year have been in place for nearly 20 years in the chemistry department, and this practice has expanded to other departments as well.

Two pivotal moments (#3 and #9) highlight our strong association with CUR: first, having Professor Mitsuru Kubota as one of the organization’s early councilors, in the second year of CUR’s history, and later, the decision to become an institutional member and now an enhanced institutional member.

Of course, some of the pivotal moments (#4, 5, 8, and 10) involve funding obtained to enhance research—particularly for faculty start-up funds, departmental endowments for research, and integrating research into the curriculum.

While every institution is unique, perhaps a take-home message from this walk through history might be a generalized list of key steps to building an undergraduate research culture on campus. I think many of our institutions would trace a similar path.

Following are seven key steps to building a campus undergraduate research culture:

- Start with a core group of committed individuals
- Align with your institutional mission statement
- Start with a small set of goals
- Build research into your curriculum
- Seek the advice and effective practices of others
- Design effective assessment measures
- Celebrate achievements and milestones

The culture of undergraduate research at my institution had a strong impact on my career. As I reflect on the various stages in my research career as a faculty member, I can select three key events that strongly shaped my research path. The first was arriving on campus to an empty laboratory with no start-up funds. That’s something that we don’t typically subject new faculty to these days! But what the situation taught me was the need to seek out grant funding, and I am extremely grateful for that early lesson. Looking back, I now recognize that the research culture at an institution
is the most critical element for faculty success. The second key event, my election as a CUR councilor nearly 20 years ago, had a profound influence on my career as I began to see the national landscape of undergraduate research and bring that perspective to my institution. Finally, while many of us change in our research directions over the years, the decision that I made to make a significant shift just as I had been promoted to full professor was one of the best decisions that I ever made. Indeed, professional development and renewal is essential at all faculty career stages.

Since research is central to CUR, let me provide a 30-second overview of my current work in laymen’s terms. I investigate compounds primarily derived from the sugar glucose that can be used in a variety of applications that include facilitating drug delivery, enhancing the texture of chocolate, and encapsulating ink in inkjet printers. The reason for the variety of applications is that these compounds spontaneously assemble into a variety of three-dimensional structures when placed in water at various temperatures and concentrations. My students and I use two techniques to identify the aggregates formed. Our first approach is a unique method that employs a molecule known as a fluorescence probe to signal what aggregate might be present. We also confirm the variety of aggregates that might form using a second technique known as optical polarizing microscopy. Then we put all of that information into a figure known as a phase diagram to show the aggregates present at various compositions and temperatures. Our fluorescence approach is so sensitive compared to traditional techniques that the resulting phase diagram is more fully depicted (and therefore thermodynamically accurate). See for example, Karukstis, et. al. 2012.

Reflections from Former Students on Their Research Experience

As I noted, my research students over the years are one of the key factors in the development of my research career. In preparing this address, I wanted to further explore the findings of our alumni survey and wrote to my former senior research students to ask them what aspect of undergraduate research, if any, had an impact on their current professional or personal lives. I received a variety of responses and will share a few.

One of my students now in academia commented on the importance of project ownership and how it developed her scientific creativity and confidence and how she tries to foster this ownership in her lab today:

I thought my entire research experience rocked. One aspect that was really important was the project ownership ... my opinion and ideas mattered. I think those feelings have helped me to develop my scientific creativity. ... I also see that, in my research lab now, the most successful undergraduate research students are the ones that have taken ownership of the project. ... So I try and foster this ownership in my lab.

Another former research student who is also a faculty member recalled my taking the group to a professional conference (we were working in the area of photosynthesis when I first started at Harvey Mudd). That event had such an impact on him that he strives to take his students to national meetings as well:

A memory that remains strong is the time you took us to a conference on photosynthesis. It was an exciting experience for me, the chance to learn about the latest advances, as well as a feeling of being part of a larger enterprise. This memory is probably why I have the pushed the department at [my institution] to let me take our current students to national meetings.

Another one of my students who is now a pediatric dentist gained an appreciation for having an inquisitive mind. That attitude has helped her in her current profession, as well as with her own children:

There are many aspects of my undergraduate research experience that I find priceless. If I had to pick one, it would be the appreciation I gained for an inquisitive mind. ... My biggest reward is to be able to walk an anxious child through a successful dental procedure and also earn his/her trust. Whether it is at home or at work, I welcome questions from my children and my patients.

Another student experienced the excitement of basic research and that led to a change in major:

I went to HMC to be an engineer but left as a scientist, and I think that is mostly because of my undergraduate research experiences. ... I am still doing, and still love doing, basic research.
A recent research student pursued both a Pharm D and a medical degree and commented on how a basic understanding of research principles aids her in interpreting primary medical literature:

Understanding basic research principles helps me interpret primary medical literature. … I feel confident in being able to deduce what type of conclusions and applications I can draw and what the limitations are of such studies.

Another one of my students who continued to medical school and is now a radiologist and a medical director of a hospital imaging department commented on the realization that research was hard work:

Summer research taught me that basic research is hard work indeed and big breakthroughs are not easy to come by.

Now, not all of my students have gone on in science. One of my projects a few years ago caught the special interest of a sophomore chemistry major because it involved investigations of the colorful properties of azo dyes. He was a highly creative scientist, but he soon realized that his passion was in an entirely different direction. He ended up completing an art major with a minor in chemistry—we have one or two students a year who take this route of completing a major at one of the other Claremont Colleges. This former student is now a professional artist, sculptor, and ceramicist. His chemistry roots are still apparent as he is fascinated by the material that he works with:

My main inspiration for my pieces is the material itself.

I also asked my research students to reflect on the less positive aspects of their undergraduate research experience. I received a few comments, including:

I would have benefited from more time writing up the work.

I wish I had had the depth of knowledge to dream, plan, and execute the whole research at that stage—the fantasy that kids have about “science” growing up.

The demands on my time from my course load constrained the amount of research that I could do during the academic year.

There are a lot of take-home messages from these comments. Each student valued a particular aspect of his or her research experience—we must keep in mind that they are individuals. I truly believe that, no matter what the skill level or level of interest, every student can make a contribution to a research project. Also, we as mentors must continue to help students understand the realities of research progress in their position as undergraduates. But, perhaps most importantly, on those days when we might wonder how significant a contribution we might be making to the scientific world, we should remind ourselves: “My research might not impact the world, but I can impact the world of my students.”

Reflections on My Involvement in CUR

Finally, let me offer just a few reflections on CUR and my involvement with this wonderful organization.

Each one of us might select different pivotal moments in CUR’s history to date. Certainly there are all of the “firsts”—the first directory of UR that launched the whole organization, the first gathering of councilors, the first national conference, the first institute, the first recruitment of individual members and then institutional members, etc. There is also CUR’s early involvement in the research funding arena with a proposal to the National Science Board in 1982 that led to the NSF-RUI program. Also important to the organization was the establishment of a national office and the eventual move of that office to Washington, D.C. As the organization has matured, it has also started to receive significant NSF funding to enlarge the scope of its work, including several major NSF Course, Curriculum, and Laboratory Improvement awards. All of these are key moments in CUR’s history.

There is no doubt that the movement to institutionalize undergraduate research has swept this country. One only needs to look at the growth in institutional members in CUR—now at its highest level in the history of CUR (see Figure 2)—and the growth in the number of institutions that have participated in one of CUR’s institutes or workshops on institutionalizing undergraduate research (Figure 3) to demonstrate this fact.
There are many tangible, successful outcomes from this institutionalization movement, including:

- Undergraduate research opportunities are available for students and faculty at a range of institutional types.
- When faculty members are hired, beginning with when the position is advertised, the expectations for undergraduate research involvement are clearly communicated.
- Many institutions now have a tradition of college-wide celebrations of undergraduate research.
- Research start-up funds for faculty are common.
- Student travel to professional conferences is valued and supported.
- While not all campuses can require undergraduate research of all students, it is possible for students to earn academic credit for their undergraduate research involvement on most campuses.
- Particularly because of the work of both Project Kaleidoscope and CUR, institutions recognize the importance of designing facilities with undergraduate research in mind.

The continuous struggle for research funding aside, some of the challenges that I see in the years ahead include:

- The need to give faculty teaching credit for mentoring undergraduate research students.
- The necessity to articulate in a more compelling manner how undergraduate research prepares students for non-research careers, in order to better argue for the student learning outcomes of undergraduate research.
- The need for many constituencies—including students, tenure and promotion committees, and funding agencies—to better appreciate the time needed for significant research progress when working with undergraduates.
- The necessity for all of us to work harder to disseminate students’ work through publication, just as we have promoted student travel to professional meetings to present their work.
- The need to address the fact that while students typically receive a stipend for their summer work, many faculty members are poorly compensated or not compensated at all for mentoring summer research students.

Thus, CUR is still needed, perhaps now more than ever, as we continue to face these additional challenges.
I would like to conclude by thanking CUR for the impact that it has had on my professional and personal life. I am grateful that:

- I have made so many friends across all disciplines and at so many types of campuses.
- I have learned so much as a consequence of the incredible atmosphere of sharing within this organization.
- I’ve had the opportunity to develop some leadership skills, try my hand at editing books, and work on so many projects that have had a significant impact on individuals, institutions, and the undergraduate research landscape in general.
- I’ve gained a better appreciation for the federal funding process and how a strong, highly respected organization can have a voice.

I want to thank all of the individuals with whom I’ve worked closely on CUR initiatives over the years and those who have supported my undergraduate research ventures, including Nancy Hensel, Tom Wenzel, Jeff Osborn, Mitch Malachowski, Bridget Gourley, Diane Husic, Mike Castellani, Lori Bettison-Varga, Shontay Kincaid, Mary Boyd, Jodi Wesemann, Mel Druelinger, Silvia Ronco, Tim Elgren, John Gupton, Jerry Van Hecke, Robert Cave, Sam Tanenbaum, and Sheldon Wettack. I’d like to extend an enormous thank-you to the entire CUR National Office staff—past and present—for their professionalism and passion for supporting our undergraduate research endeavors. I especially thank Li-Cor Biosciences for its sponsorship of this award and for all that company does to enable faculty to engage undergraduates in research with state-of-the art instrumentation. Most importantly, I thank the many students for whom I’ve had the privilege of serving as a research mentor—they continue to inspire me as they thrive well beyond their days at Harvey Mudd College.

It has truly been a rewarding undergraduate research journey thus far, and I look forward to a continued strong collaboration with CUR in the years ahead.

References
HMC Impact Project, 2009-2010 Harvey Mudd College Alumni Survey.

Kerry K. Karukstis
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Kerry K. Karukstis is professor of chemistry at Harvey Mudd College and holds the Ray and Mary Ingwersen Chair in Chemistry. She also currently serves as chair of the faculty at Harvey Mudd College and is the most recent recipient of the Joseph B. Platt Chair in Effective Teaching. She joined the faculty at Harvey Mudd College in 1984, regularly teaches courses in general chemistry and physical chemistry, and maintains an active research laboratory with undergraduates as collaborators, using spectroscopic and light scattering techniques to characterize the structure and physical properties of surfactant aggregates and macromolecular host guest systems. Karukstis is a long-time member of the Council on Undergraduate Research, serving as Councilor for the Chemistry Division (1993-2009), Chemistry Division Chair (2001-2003), CUR Secretary (2005-2006), CUR President (2007-2008), and co-editor of Developing and Sustaining a Research-Supportive Curriculum: A Compendium of Successful Practices (2007) and Transformative Research at Predominantly Undergraduate Institutions (2010). She was recognized for her service to the organization as CUR Volunteer of the Year in both 2004 and 2010.
What’s in a Name? A Brief History of Undergraduate Research

CUR Fellow’s Address at CUR’s 2012 National Conference at The College of New Jersey

Let’s begin with a pop quiz about when important events occurred in the history of undergraduate research. (The answers appear in the following text.)

**Pop Quiz  Identify the Year (A Brief History of Undergraduate Research)**

For fun, test your knowledge of the history of undergraduate research. Score 1 point for each correct year.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>WHAT YEAR?</th>
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<tbody>
<tr>
<td>The merger of CUR and NCUR becomes official.</td>
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<tr>
<td>Undergraduate research designated as a “high impact educational practice” (Kuh).</td>
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<tr>
<td>The Boyer Report, <em>Reinventing Undergraduate Education: A Blueprint for America’s Research Universities</em>, which emphasizes undergraduate research, is published, and the Reinvention Center is established at Stony Brook.</td>
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</tr>
<tr>
<td>Project Kaleidoscope (PKAL) organizes to reform STEM education.</td>
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<tr>
<td>National Conferences on Undergraduate Research (NCUR) holds its first conference.</td>
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</tr>
<tr>
<td>The National Science Foundation (NSF) introduces the Research Experiences for Undergraduates (REU) program.</td>
<td></td>
</tr>
<tr>
<td>CUR hosts its first National Conference in this year.</td>
<td></td>
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<tr>
<td><strong>Bonus Question:</strong> On what campus was the first CUR National Conference held?</td>
<td></td>
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<tr>
<td>Considered the first undergraduate research program, the Undergraduate Research Opportunities Program (UROP) was founded at MIT in this year.</td>
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<tr>
<td><strong>Bonus question:</strong> Name the first director of UROP at MIT.</td>
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<tr>
<td>NSF co-sponsors a conference on strengthening college physics teaching on the undergraduate level. NSF is encouraged to expand research opportunities for college faculty and to encourage undergraduate research, which it will do in the ensuing years.</td>
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<tr>
<td>At Union College, two terms of undergraduate research are required for the physics BS degree beginning in this year.</td>
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<tr>
<td>William A. Noyes speaks at the American Chemical Society: “Two purposes should be constantly in the mind of the teacher who directs research work of undergraduates. First, the student should be trained in the use of chemical literature. He should learn how to find for himself the results of previous work on the problem he is studying. Second, he should be taught to develop personal initiative in attacking a problem. He should never be considered merely an agent to carry out an experiment which the teacher wishes to be performed.”</td>
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<tr>
<td>The University of Chicago establishes an undergraduate research prize in honor of Howard Taylor Ricketts, American pathologist, who uncovered the cause of Rocky Mountain Spotted Fever.</td>
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<td>Cecil K. Drinker publishes the results of his survey “Undergraduate Research Work in Medical Schools” in <em>Science</em>.</td>
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<tr>
<td>A group of students and faculty at Cornell establishes the honor society Sigma Xi for “Companions in Zealous Research.”</td>
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</tr>
<tr>
<td><strong>Bonus Question:</strong> Women were admitted to Sigma Xi in what year?</td>
<td></td>
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<tr>
<td>A German professor, Wilhelm von Humboldt, recommends unity between research and teaching with a commitment to discovery—“an unceasing process of inquiry.”</td>
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The quiz provides a way to engage us in thinking about the history of undergraduate research, as it seems important that we understand what has come before. This can be of tremendous help not only to the present but also to the future and to any plan of action. As Eugene O’Neill writes in *A Long Day’s Journey into Night*, “The past is the present, isn’t it? It’s the future, too.”

The assignment for a CUR Fellow address is to offer a brief history of the work that has led to this tremendous honor. Past CUR Fellow addresses have done this exceedingly well. I remember, in particular, the 2006 address by John Mateja, who called for action by CUR members to ensure that research becomes the standard by which we educate our students.

I’ll begin with a brief history of undergraduate research, before discussing my own work as a faculty member and as a director of an undergraduate research program.

Deconstructing the task for a CUR Fellow, I found that the focus on history led me to consider the etymology of the term *undergraduate research*. As a humanist, I wanted to explore its origins. When was undergraduate research popularized and branded as such? As Shakespeare put it, “What’s in a name?” Within a name lies a great deal of meaning and power. My curiosity about the history of undergraduate research had actually been building before my designation as a CUR Fellow. One of my colleagues at Utah State University teased me about our 35th anniversary celebration of undergraduate research in 2010; he said he had done undergraduate research at the Polytechnic Institute of Brooklyn in the early 1960s, well before our program’s 1975 start. He even brought his thesis to prove it! (I began terming him “the world’s oldest living undergraduate researcher.”)

My interest in undergraduate research’s history was also aroused by a comment in an *Inside Higher Education* article that focused on a pair of archaeologists from the University of Central Florida who started their digs in 1983. They said, “We’ve done undergraduate research since before there was undergraduate research” (Redden 2012). 1983? Hmm.

Edward Ayers, president of the University of Richmond, in a plenary address delivered at this year’s CUR National Conference, noted that undergraduate research is a “relative-recent” educational phenomenon. Several written sources, such as Carolyn Ash Merkel’s report to the Association of American Universities on undergraduate research (2001), suggest that the practice began in 1969 with the founding of the Undergraduate Research Opportunities Program (UROP) at the Massachusetts Institute of Technology (MIT), under the direction of the visionary Margaret MacVicar. Certainly that was a key date in the development of undergraduate research, both on the MIT campus and nationally. But as I dug further, I found that undergraduate research was in place much, much earlier.

Several historical timelines provided clues. The National Science Foundation traces its history from the 1940s, even before it was authorized by Congress in a bill signed by President Truman in 1950. (See http://www.nsf.gov/news/special_reports/history-nsf/timeline/index.jsp.) A key player in stimulating educational innovation, NSF has been interested in undergraduate research certainly since its 1953 meeting to discuss improving undergraduate education in the sciences. Likewise, the Research Corporation for Science Advancement, which celebrates its centennial in 2012, marks on its calendar important dates beginning soon after its establishment of influencing science education in secondary schools and colleges. (See http://www.rescorp.org/about-rcsa/history/timeline.) As founder Frederick Gardner Cottrell famously said, “Bet on the youngsters. They are long shots but some of them pay off.”

Brian Andreen, program officer at the Research Council, was instrumental in the formation of the Council on Undergraduate Research when he began compiling a directory of undergraduate research opportunities in chemistry at primarily undergraduate institutions (PUIs) in 1978. It is from this action that CUR charts its own beginning. (See http://www.cur.org/about_cur/history/timeline/) It is fitting that the student award that accompanies the CUR Fellowship is named in Andreen’s honor. CUR focused on faculty development and undergraduate research, evidenced in its first National Conference, hosted by Colgate in 1985.

CUR has suggested programming and educational innovations to foundations as part of the fulfillment of its advocacy mission. Just as MIT’s centralized office galvanized undergraduate research on its own campus, CUR, as a national
organization devoted to undergraduate research, has stimulated further activity. The National Science Foundation (NSF) began its Research Experiences for Undergraduates (REU) in 1986. The National Conference on Undergraduate Research (NCUR) held its first meeting in 1987. Project Kaleidoscope (PKAL) organized in 1989 with a mission to reform education in science, technology, engineering, and math (STEM)—although at that time, this thrust was abbreviated as SMET! Important white papers such as the Boyer Report in 1998, *Reinventing Undergraduate Education: A Blueprint for America’s Research Universities*, and, more recently, the *Bio 2010* report (2003) spurred action on campuses. George Kuh’s work (2008) provided demonstrable evidence that undergraduate research has significant impact on students.

The more I explored the origins of undergraduate research, the more fascinating the search became. Very few contemporary accounts of the historical origins of undergraduate research exist, however. Laursen et al (2010) offer a brief—but fuller than others—history of undergraduate research in the sciences in their *Undergraduate Research in the Sciences: Engaging Students in Real Science*, which helped set me on the path to uncover instances of undergraduate research prior to the 1969 formation of MIT’s UROP. Following is a sampling of what I found.

Undergraduate research was present throughout the twentieth century. For instance, Hope College notes in its history of undergraduate research that Professors Van Zyl and Kleinheksel began a program in chemistry in 1947. Wooster College reorganized its curriculum in 1948 to emphasize student research. Pacific Lutheran College received its first grant from the Research Corporation to support undergraduate research in 1958 and its first NSF grant for undergraduate research in 1962 (http://urc.arizona.edu/A%20Compendium%20of%20UndergraduateResearch%20Programs.cfm).

**Undergraduate Research at the Beginning of the Twentieth Century**

Even earlier, in the first part of the twentieth century, undergraduate research is frequently mentioned in the pages of *Science*, the magazine of the American Association for the Advancement of Science (AAAS). William A. Noyes speaks of the “Proper methods of conducting undergraduate research” in a 1922 report from the American Chemical Society (Parsons). Noyes says the student is not just a go-fer, but a learner and contributor:

> Two purposes should be constantly in the mind of the teacher who directs research work of undergraduates. First, the student should be trained in the use of chemical literature. He should learn how to find for himself the results of previous work on the problem he is studying. Second, he should be taught to develop personal initiative in attacking a problem. He should never be considered merely an agent to carry out an experiment which the teacher wishes to be performed.” (Parsons, 400)

In the same year, 1922, Union College, a leader in undergraduate research, began requiring two terms of undergraduate research for a BS degree in physics; more science fields soon followed suit (Peak 1995). Peter Wold, the physics department’s chair from 1920-1945, arrived at Union from the Western Electric Company and brought with him the perspective that learning by doing was better than learning from textbooks. Under Union’s president Eliphalet Nott (“president before Lincoln was born and still president after Lincoln was dead,” according to Peak), Union became the first institution in America to replace the traditional Latin and Greek requirements with French and German, the latter change reflecting the growing influence of German higher education.

Sigma Xi was a frontrunner in terms of supporting students interested in research—or as the students and faculty members at Cornell called them when they organized in 1886—“Companions in Zealous Research.” (A side note: It is disconcerting in this age of gender-neutral language to have all scientists referred to as he or him even though women were doing research and Sigma Xi had admitted women just two years after its initial formation. A 1913 report from a Kansas Sigma Xi chapter listed among its members Inez Smith, whose work on “The Ciliates of Kansas” was to be published in the *Kansas University Science Bulletin.*) (Abrams et al 1913, p. 18).

Sigma Xi chapters regularly awarded prizes for undergraduate research in the 1930s, but prizes for undergraduate research in fact had been awarded much earlier, such as at the University of Chicago, which established an award in
1912 in memory of pathologist Howard Ricketts. He is credited with identifying the source of Rocky Mountain Spotted Fever, and, as did many scientists of the day, he used himself as a human subject in testing typhoid pathogens—with fatal results.

Evidence exists that practical application of undergraduate research was emphasized but not at the expense of the undergraduate’s personal and professional growth. At its 1919 meeting, the Indiana Academy of Science heard a report on “Undergraduate Research in Our Colleges and Universities” by members of the Scientech Club. The club’s members had carefully surveyed colleges and universities in the state, and Harold A. Shonle reported their findings, including a recommendation to require a thesis to ensure scientific training of undergraduates. Shonle called attention in his report to the dual (and dueling) approaches to education labeled knowledge and discovery, preferring the advantages of discovery in undergraduate research. As he put it:

A recent cartoon depicted a graduate groaning under a load of books marked Knowledge and unable to accept the volume of Wisdom offered him. The wisdom and judgment secured from using this knowledge acquired are lacking. Their knowledge is too often unorganized and disconnected. They know their theories perhaps, but they do not know how to apply them. We do not expect the universities to turn out men in four years who are capable of solving hard problems, but it is discouraging when a chemist cannot prepare a simple soap without being minutely instructed or when an engineer is unable to apply his theories to a bridge which differed from the one in the text. (Proceedings, 75)

The debate between the philosophical approaches toward undergraduate education—providing knowledge (filling an empty vessel) versus wisdom (application or discovery)—profoundly influenced the undergraduate curriculum.

The Scientech Club held that students benefit greatly from engaging in research: “The Club believes that the fulfillment of the above thesis requirement, the conditions laid down in the resolutions, will in all instances be a great mental asset to the individual irrespective of his future activities, will induce in great measure the development of latent research in the student body, and will distinctly promote the research atmosphere of the institution” (Proceedings, 77). These words from almost a century ago could be seen as just as appropriate today.

The Indiana Scientech Club was joined in its fervor for undergraduate research by the authors of a 1906 article in the American Gas Light Journal, a professional journal for engineers, which reported on the 29th annual meeting held by the Western Gas Association in Cleveland in May of that year. Professor Burgess of the University of Wisconsin made the following statement to the assembly:

The primary object in requiring a student, before graduation, to carry on a piece of investigation is
to throw him as largely as possible upon his own resources; to develop his capabilities of reasoning and thinking; to give play to his ingenuity; and to impress him with the importance of planning and laying out a piece of research in advance of its execution." (Burgess, 224)

These sentiments were echoed precisely in a 1921 report on land-grant colleges and universities from the U.S. Office of Education that noted that “Undergraduate research first and foremost should be of benefit to the student” (Statistics of Land-grant Colleges and Universities, 109). As a faculty member at a land-grant university, I found this attitude heartening and particularly appropriate given the current sesquicentennial celebration of the Morrill Act, signed by President Lincoln, that established these institutions.

The pragmatic nature of undergraduate research meant that students might very well contribute to the knowledge base in their fields. Certainly Inez Smith, the undergraduate member of Sigma Xi at Kansas mentioned earlier, did so, but she was just one of many students across the nation cited in notes from Sigma Xi chapters who achieved publication before graduating.

The theme of undergraduate research and recommendations for its incorporation into an undergraduate’s education carried through many journals in the early 1900s. In addition to Science and American Scientist, other periodicals such as the Journal of the American Medical Association (JAMA) discussed the efficacy of undergraduate research. In a 1901 issue of JAMA, authors debated its merits. W. S. Christopher privileged knowledge and experience: “The time for the medical man to undertake research work is when his experience has become sufficiently ripe for him to formulate his own problems. Then his research work will have some life in it” (737).

In a contrasting view in the same issue, a lengthy overview of “University Work in Medical Education,” another author notes that “‘research work’ may be unreservedly recommended to all undergraduates. ... It will no longer do to urge students to gain their principal knowledge from books. The knowledge which a student really makes his own has to be wrested with a certain amount of difficulty from Nature herself” (767). Within a decade, the prevalence of undergraduate research for medical students was underscored in a 1912 article in Science, “Undergraduate Research Work in Medical Schools,” in which Cecil K. Drinker published a lengthy and detailed report of a survey he conducted.

While it may seem that the sciences held sway in undergraduate research, it was not uncommon for undergraduates to undertake research in the humanities, as a Smith student did in studying in Spain in 1904: “My experience in studying in Spain is limited to work done in libraries and with private individuals. Women are admitted to the University of Madrid both for graduate and undergraduate research work in Spain” (The Smith College Alumni Monthly, p. 521). In the pages of the Journal of the National Association of Biblical Instructors, it was suggested in 1933 that “a modest journal ... devoted to the publication of selected examples of undergraduate research, might be useful both to the members of the NABI and to their students” (90).

**Higher Education in the Nineteenth Century**

The appropriate education for an undergraduate in this century generally was acquiring knowledge through studying the traditional curriculum: Latin, Greek, and classical literature—with a good dose of moral education—as the aim of eighteenth and nineteenth century education was usually to educate the clergy. But as higher education became more diversified, charged with the education of scientists as well as clergy, a debate erupted. The examination of the purpose of undergraduate education is rooted in the tug of war in higher education in the United States between a British model—the tutorial—and a German model—the seminar and also the laboratory. Wilhelm von Humboldt, who founded the University of Berlin in 1810, where a good many Americans would undertake graduate work, is credited with stressing an approach to education that unified teaching and research, coupled with “an unceasing process of inquiry” (1970). In doing so, he was enacting the philosophy of his teacher, Fredrich August Wolf, who made “research and discovery, not initiation into a closed body of knowledge, the primary goal of an academic philologist” (Diehl 1978, 147-148).

Just as the Boyer Commission report of 1998 offered a blueprint for America’s research universities, “It was from blueprints drawn after the German academic pattern, transported across the ocean by these scholars and many of their compatriots, that the ground was prepared for a successful
reorganization of American institutions of higher education” (quoted in Diehl; original by Jurgen Herbst, The German Historical School in American Scholarship, Ithaca, 1969, p. 2).

While there were detractors concerning the German model, such as the Yale Report of 1828, the curriculum of American higher education would change, eventually resulting in specialized disciplines and majors. (See Larry Cuban’s How Scholars Trumped Teachers: Change Without Reform in University Curriculum, Teaching, and Research, 1890-1990 for a discussion of curriculum change and specialization in majors.)

It is from this German model of discovery that America’s research-driven universities emerged. Americans went to Germany for graduate education as access to education in England was largely cut off to them during the Revolutionary War and the War of 1812. By the end of the nineteenth century, in fact, Yale had changed its tune and become a leader in the German approach, hiring faculty educated at German universities.

What I’ve tried to demonstrate in this brief overview is that undergraduate research has certainly been in existence for 200 years, not just since the formation of the Council on Undergraduate Research in 1978. It was the formation of CUR, though, that institutionalized undergraduate research in higher education and led to its being termed a “movement,” notable for the tremendous impact it has on both students and faculty. Likewise, NCUR gave voice to undergraduate researchers, scholars, and artists. The “Joint Statement” by CUR and NCUR (2005) that put forth the belief that “undergraduate research is the pedagogy of the 21st century” builds on work done in the 19th and 20th centuries.

How well did you perform on the pop quiz?

**A Personal History**

Impact is a good term for the effect of undergraduate research on my own career. But I have to confess that I didn’t always think of the collaborative work I did with students as undergraduate research. That was simply not a term common to my discipline of English.

My own philosophy of education has been influenced by three theorists in language arts and English: Louise Rosenblatt and her *Literature as Exploration* (1938), which introduced reader-response theory; James Moffett and his *Student-Centered Language Arts Curriculum, K-12* (1968); and Walter Loban (e.g., *Language Development: Kindergarten through Grade Twelve*, 1976). Loban suggested at a professional conference that I attended early in my career, some thirty years ago, that students should engage in “meaningful, authentic work.” From these three theorists, I adopted a philosophy of student-centered teaching and learning, a philosophy that laid the groundwork for becoming an advocate for student-faculty collaboration. Loban’s idea translated into my designing writing assignments that might be worthy of publication in professional venues. In my seminar for Writing Fellows, for instance, well over a dozen students wrote essays accepted for publication in a professional journal. In one instance, two students took the lead in designing “an ideal space” for a writing center in an interdisciplinary research project; a colleague in interior design and I came on as secondary authors, and that essay was published in an edited volume (Hadfield et al 2003). More recently, two colleagues, two students, and I wrote an essay for another edited volume, *Undergraduate Research in English Studies* (Cooper-Rompato et al 2010).

My efforts to involve students in my own scholarship began even earlier. In my book *A Schoolmarm All My Life*, there is a brief line, “Susan Boor proved a capable research assistant.” That statement doesn’t really fully illuminate the important contribution that Susan, an undergraduate, made. She and I traveled to Salt Lake City weekly to transcribe personal narratives and journals located in the archives there. Susan was crucial to my development as a mentor to undergraduates. When I touched base with her recently, she recalled, “I remember your project fondly—stopping at Hardee’s for breakfast biscuits early in the morning (you bought—an important incentive for a poor undergrad), hours scrolling through microfilm.” We uncovered three dozen historic diaries through our joint efforts.

As I mentioned, when I first began collaborating with students on scholarly projects, I did not term it undergraduate research. The reasons for this are tied to how scholarship is viewed in the humanities, which includes as the gold standard for research, working alone—the iconic writer in the tiny garret apartment—or as Virginia Wolfe memorably put it, having *A Room of One’s Own*. It often takes years of reading and experience to be a scholar, a characteristic that human-
ists share with mathematicians. There is also a lack of models for research apprentices, worsened by a paucity of funding to hire assistants. And, finally, instruction in the responsible conduct of research in the humanities is often limited to one standard of avoiding academic dishonesty, plagiarism. While there are challenges in the humanities, there are also possibilities: summer undergraduate research assistantships, NEH-style summer seminars, departmental symposia, the poster as a different medium for dissemination, and new approaches to collaborative research. The latter also means that faculty roles and rewards must take into account mentorship of undergraduates.

A decade ago, Ron Dotterer noted that “the humanities have been slow to participate” in undergraduate research (2002). Since then, CUR has established a new Division of Arts and Humanities, added humanities presentations to its annual Posters on the Hill, and published an edited volume on Creative Inquiry in the Arts & Humanities (Klos et al 2011), as well as Behling’s Reading, Writing, and Research (2010). In my own state, the Utah Humanities Council established fellowships for undergraduate researchers (Buckingham et al 2012).

It is only in the past fifteen years that I’ve come to realize that “meaningful, authentic writing assignments” have the capacity to be termed undergraduate research. My own personal and professional goal as a professor of English is to ensure that the students with whom I work have opportunities for such research. I aim to achieve the objective of ensuring that undergraduates in the humanities have the same opportunities as those in the sciences to benefit from undertaking real research that can inform and have an impact on a field. On a larger canvas, as an administrator of a centralized undergraduate research program, my intention is to ensure that all students have the opportunity to get their hands on research—a phrase that became our tagline.

Utah State University’s Undergraduate Research Program was established in 1975. Using that foundation and history as a basis, for eleven years as its director, I have worked with my colleagues to showcase student researchers, including an undergraduate research day at the state capitol and the Utah Conference on Undergraduate Research (Kinkead and UCUR 2012). I have integrated instruction on ethics in research, established the Research Fellows Program for early immersion in undergraduate research, and improved public relations and marketing so that undergraduate researchers figure prominently in the university’s external communications.

Assessment is crucial to improving a program, and in this effort, we have made several strides. The application for a transcript designation of “Undergraduate Research Scholar” helps us collect information on students’ dissemination successes. A large-scale curriculum-mapping project in which a team of undergraduates reviewed and analyzed all syllabi on campus for evidence of skills and ethics important to undergraduate research provided essential information to us and authentic educational research for them (Kinkead and Fox 2012). We expect to use the students’ report to encourage administrators and faculty to be more inclusive of UR in their syllabi, including having faculty members become more transparent about their own work as researchers, scholars, and artists. In fact, I urge all faculty members to talk in their classes or include on their syllabi how their work as a researcher, scholar, or artist influences their teaching. This is made easier when the course-management software system includes a standard template for faculty biographies. I credit our USU Undergraduate Research Advisory Board—composed of faculty and student representatives from every college—not only with advocating student research on campus but also with establishing an assessment agenda.

My belief in the transformative power of undergraduate research has also guided my scholarly agenda. My volume, Valuing and Supporting Undergraduate Research (2003), is considered the first volume on undergraduate research published outside of the conventional CUR publications venue, and it also includes a chapter on undergraduate research at the two-year college. My book Advancing Undergraduate Research: Marketing, Communications and Fundraising was published by CUR early in 2011. It offers pragmatic advice about promoting undergraduate research on individual campuses and draws from a wealth of examples derived from undergraduate research programs across the nation.

Undergraduate Research in English Studies, which I co-edited and wrote with Laurie Grobman (2010), is the first volume to address the role of undergraduate research in this field; we seek to mobilize the profession in enhancing opportunities for students. I am currently at work on a textbook, Research
*Methods in Writing Studies*, which may be the first that is directed to an undergraduate audience. This volume will feature essays from students published in *Young Scholars in Writing*, a peer-reviewed journal for students doing research in writing; it will celebrate a decade of high-quality essays with its next volume.

**Call to Action**

As I conclude, let me ask some questions that suggest actions that CUR members and CUR as an organization might take. In making these recommendations, I admit that I was influenced early in my childhood by the pharaoh in *The Ten Commandants*, who ended each pronouncement with these words: “So let it be written. So let it be done.” My version of the pharaoh’s command is: “If it’s not written, it didn’t happen.”

- First, what are the histories of undergraduate research in our various fields? Is there a history of undergraduate research for your home department? For the larger field? Might I suggest as CUR nears its 40th anniversary in 2018 that its divisions consider how they might record this history?
- What is the history of the undergraduate research program on your campus? In the recent *Undergraduate Research Offices & Programs* (Kinkead and Blockus 2012), we ensured that each chapter describing a program began with its history. And we wrote such a history at Utah State University for our research magazine (“Undergraduate Research and Creative Opportunity Grants” 2008).
- Is there a role for a CUR/NCUR Historian to ensure that valuable archives are maintained and that they are mined for information, histories, and development opportunities?
- Shouldn’t there be an overarching history of undergraduate research? My address today skimmed the surface of the rich resources that might function as the basis for such a written history.
- And let’s not forget undergraduate research in an international frame. In 1907, the British House of Commons used the term “undergraduate research” and noted: “Do not you think it is one of the functions of a University not only to communicate existing knowledge but to extend the boundaries of knowledge” (Great Britain 1907).
- Might some dissertation research focus on the history of undergraduate research?
- While it may seem mundane, there are no entries on undergraduate research in the *Oxford English Dictionary* (OED) or in Wikipedia. Likewise, there is, at this moment, no entry for CUR in Wikipedia. These gaps need to be filled.
- As noted above, I encourage faculty to make their research, scholarship, and artistic endeavors transparent to students in the classroom by including such information on their syllabi or course-management systems and by talking about their work in their classes, as appropriate.

I echo John Mateja’s 2006 call to action in his CUR Fellow Address about the importance of funding for undergraduate research, but I add and stress the need for increasing or starting funding for undergraduate research in the humanities, where funding is rare, if not non-existent. My first funded project—to work on *A Schoolmarm All My Life*—was a grant of $3,000, big money for a humanities faculty member in the 1980s. Frankly, funding for humanistic scholarship is under attack. Recently, a 10-percent cut in National Endowment for the Humanities (NEH) funding and the possible deletion of the Mitchell Scholarship for study in Ireland and Northern Ireland have been proposed.

When I look at the timeline I’ve sketched of the past 200 years, it is possible to see the tremendous impact of collaborative work between faculty and students and by the organizations that have supported them. It is, however, the institutionalization of undergraduate research through the organization of the Council on Undergraduate Research and the National Conference on Undergraduate Research that have given formal meaning to the term undergraduate research.

My passion for ensuring that undergraduate research is accessible to as many students as possible, not only on my own campus and in my own field of study, but also to students beyond my home territory is rooted in my belief that hands-on learning can change lives. Undergraduate research
provides the possibility for life-long relationships between mentors and students, enhanced learning, and impact on the scholarly fields themselves. As a first-generation college student myself, I found college to be an exhilarating experience, filled with the potential for inquiry and discovery. I want nothing less for the students with whom I work.

Acknowledgement

My nomination for the prestigious CUR Fellow Award is the result of work by my friends, colleagues, and students, particularly Laurie Grobman of Penn State-Berks, who initiated the nomination, and Christie Fox, Director of Honors at Utah State, who assembled the portfolio. I’m grateful to all of those who wrote on my behalf and to the CUR Fellow Committee for selecting me. Additionally, I want to thank the staff members of the CUR National Office, who have always been supportive and helpful, as well as my own colleagues in the Research Office at Utah State University. Being at an institution that began its undergraduate research program in 1975 and that has a faculty ethic of working with undergraduates on meaningful research has been an enormous boon to my own professional and personal development. I have learned much from the student researchers with whom I work.

My query to CUR colleagues for input on the history of undergraduate research resulted in several valuable contributions: Bethany Usher of George Mason University offered a very helpful search tool, Google's NGRAM Viewer; Marcus Webster shared a timeline; Michael Nelson chimed in with dates; and David Peak offered a history of physics at Union College. My interest in American higher education was first aroused by David Russell's excellent historical research (1991). David F. Lancy, as always, served as reader, reactor, in American higher education was first aroused by David Russell's excellent historical research (1991). David F. Lancy, as always, served as reader, reactor, and partner.

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Joyce Kinkead
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Kinkead has served as associate vice president of research, 2001-2011, at Utah State University, where she is professor of English. Her publications that focus on undergraduate research include Valuing and Supporting Undergraduate Research (2003); Undergraduate Research in English Studies (2010); Advancing Undergraduate Research: Marketing, Communications, and Fundraising (2011); and Undergraduate Research Offices and Programs: Models and Practices (2012).
Deconstructing “Race” in (Re)constructing Change
Ayanna F. Brown, Holly Copot, Elmhurst College, abrown@elmhurst.edu

Undergraduate research is rooted in developing a collaborative relationship between faculty and students within a discipline. This vignette illustrates how our research improved academics and aided students’ personal growth.

In examining “race,” I recognize there can be resistance in some educational circles that stifle undergraduate teacher candidates’ preparation. Despite the reality of the consequences of racial “silences” and its impact on learning, discussions of “race” in teacher education remain marginalized or amalgamated with other topics like gender and class. Undergraduate research on “race” and education requires a willingness to be uncomfortable yet motivated to work within that discomfort to understand our social and political histories. Our research used qualitative data along with our personal narratives as tools for meaning making and a form of empirical evidence to think about education and teacher praxis.

Holly Copot: When as a student I was offered the position of research assistant to Dr. Brown in the Department of Education, I did not truly understand the scope of what would be happening. I expected to simply code the data of how other students talked about race. I had no idea that I would be deconstructing my own views of race and reconstructing a new meaning. I was simply developing a qualitative coding process to use with other undergraduates’ reflections, yet it was my own thoughts about “race” that I began to question. I learned that nuanced and passive racism could be very present in our lives, even when we thought ourselves to be open-minded.

Ayanna F. Brown: Working with Holly, I was able to understand barriers teacher candidates face. These barriers are not just in discussing “race,” but also in the reflective process, which allows us to critical question our choices and how we’ve engaged communities. Holly and I discussed our coding procedures as well as our frames of reference, which guided how we saw the data. From these dialogues, we pushed both the social constructions of “race” and our personal assumptions, which enriched our findings. My undergraduate students now participate in similar sociolinguistic coding as a course component. Undergraduate research was more than sets of procedures, but also a commitment to helping teacher candidates rethink their roles in the education profession and the needed changes that might most impact the lives of children they have yet to teach.

Copot is now an elementary-school teacher, and since their collaboration, Brown has presented findings from their research at three national conferences.

Students’ Commitment to Undergraduate Research
Karen Havholm, University of Wisconsin-Eau Claire, havholkg@uwec.edu

For nearly 15 years, UW-Eau Claire has funded much of its faculty-mentored undergraduate research, scholarship, and creative activity through “differential tuition.” This student-led and student-supported program of supplemental tuition has had a major impact on the level and breadth of undergraduate research activity on our campus.

Before differential tuition was instituted, the University of Wisconsin System had designated our regional comprehensive university as “The Center of Excellence for Faculty and Undergraduate Student Research Collaboration.” This status reflected UW-Eau Claire’s strong tradition of engaging students in collaborative research with faculty scholars.

The center’s funding, which was from both state and donor funding through the UW-Eau Claire Foundation, eventually was not sufficient to support student demand for involvement in research. Campus supporters worked with student government to create a plan for a tuition supplement, initially $100 per student per year. These additional tuition funds, accounted for separately from regular tuition, were used to support value-added experiential learning opportunities on campus, with undergraduate research as a major component. A central research office solicits research proposals and manages their review. In 2011-12, 380 students working on 225 projects were supported with stipends, travel, and supplies; 87 faculty received stipends for mentoring students on summer projects. In addition, 250 students received support for travel to conferences to present their results.

In 2010, the student government voted to raise the tuition supplement, in increments, to a level of $1200 per student per year by 2013-14. This will allow undergraduate research to continue to grow, and this will enhance many other high-impact educational practices, including global and intercultural immersion experiences and internships. The increased support from differential tuition funds has already supported a new program for international research and research/service learning, which has sent 100 students and 26 faculty members to 19 countries in its first two years.
Students have been instrumental in developing the plan, allocating funding, and evaluating the outcomes. They recognize the passion in student and faculty voices when they recount how students are transformed by research experiences. Raising supplemental tuition was not an easy decision for students, but they are committed to investing directly in learning opportunities that add value to their UW-Eau Claire degree.

Undergraduate Research Training Blossoms at VCU: Pollinated by Students
Sarah E. Golding, Nicholas A. Pullen, Tenchee D. Lama Tamong*, Nisan M. Hubbard*, Herb H. Hill, and Suzanne E. Barbour, Departments of Biology, Biochemistry, the Center for Health Disparities, and the Office of Research, Virginia Commonwealth University, segolding@vcu.edu.

*undergraduate researcher

In November 2010 we attended the Annual Biomedical Research Conference for Minority Students (ABRCMS), and our two student attendees noticed with surprise that some other institutions had brought more than 30 people. They also noticed that some of these campus groups acted as “communities” that actively supported and coached each other—“behaving more like athletes than researchers,” in the words of one student. Said another, “We vowed to go to VCU, promote that culture, and return in 2011 with more students, and win awards”

Throughout the following year, these two students actively engaged peers interested in undergraduate research at VCU, recruited faculty advisors, and formed the Student Research Organization (SRO). The first meeting attracted 85 students from nine departments, even though the organizers initially intended to focus on students interested in biomedical research and had booked a 40-seat room. Membership now exceeds 130, and the student leaders have expanded the focus to all areas of scholarship, naming chairpersons for specific disciplines.

The student leaders have solicited sponsorship from professional organizations, hosted seminars, and sponsored a showcase of undergraduate research. The broad student participation prompted faculty members to listen and think about how to meet the ever-increasing demands of the student body. As a result of student and faculty effort, in November 2011, twenty-two VCU students attended ABRCMS. Prior to and during the trip they acted as a unit, supporting each other’s work. They presented seventeen posters and five talks, one of which won a top award.

It has been an exciting and productive start for the SRO, which is poised to make substantial contributions to VCU’s strategic plan, called “Quest for Distinction.” The impetus can be traced back to two undergraduate researchers who pursued a dream that started at the 2010 ABRCMS meeting.

Student Research on Concept Mapping Informs My Teaching
Bryan D. White, University of Washington Bothell, bwhite@uwb.edu.

Literature on learning in science is increasingly focused on making connections between science and students’ everyday lives. Last year during the first and last day of class, I had students in my biochemistry class create concept maps answering the question, “What is biochemistry?” Drawing on the literature, one focus of this course was to emphasize connections between biochemistry and students’ lives. My hope was that through concept mapping I would be able to see evidence of connections students were making between biochemistry concepts, as well as connections they were forming between biochemistry and their own lives.

I enlisted the help of Camilla Misa, an undergraduate in biology, to analyze this data set of pre-class and post-class concept maps. Although I have mentored many students in basic scientific research, this was my first adventure into mentoring a student in biology-education research. Misa used the rich data set to make observations and determine methods for analyzing changes in the students’ concept maps.

This project generated in my student tremendous independence, excitement, and ownership of a research endeavor that has impacted both her study habits and my classroom practices. She found that although I thought I was emphasizing connections between biochemistry and the lives of students, not a single example appeared on the maps. Her findings have prompted me to use a concept-mapping exercise as homework midway through the quarter to force students to articulate connections between scientific concepts and their everyday lives. My experiences with mentoring Camilla Misa and her findings have changed how I utilize concept maps and have made me eager to engage students in future research into biology education.

Water adsorption on the three most abundant clay minerals found in the atmosphere, including kaolinite, illite and montmorillonite, was measured as a function of relative humidity (RH), using an attenuated total reflectance (HATR) Fourier transform infrared (FTIR) spectrometer equipped with a flow cell. The measured water content was in excellent agreement with previous data and was fit using the BET and Freundlich adsorption isotherm models. Although the BET model represents the data well at low RH (<60% RH), fit integrity is lost at higher RH. Upon fitting the Freundlich model to the data, two distinct adsorption regimes are revealed in all three clays. The variability in adsorption properties observed was attributed to different water uptake mechanisms by the three clays.

Courtney Hatch is an assistant professor of chemistry at Hendrix College. Jadon Wiese currently attends the University of Arkansas Medical School. Cameron Crane is in graduate school in chemistry at the University of Arkansas. Kenneth ‘Josh’ Harris is still enrolled at Hendrix College. Gracie Kloss is in pharmacy school at the University of Tennessee. This study was supported by NSF (#ATM-0928121) and by a single investigator Cottrell College Science Award. Jadon Wiese received support from an ASGC Research Infrastructure Grant. Cameron Crane received support from the Hendrix Odyssey Program.

Burke K, Riccardi C, Buthelezi T.

We investigated the thermosolvatochromism of nitrospiropyran and merocyanine free and bound to cyclodextrin in dimethylsulfoxide (DMSO)-water binary system. The nitrospiropyran interconverts to merocyanine in response to heat or light. We converted nitrospiropyran (SP) to merocyanine (MC) by heating the sample to 55 °C. When cooled to 25 °C the MC sample converted back to SP. We found that the interconversion of spiropyran to merocyanine in DMSO-water is stable and does not suffer from thermal or photofatigue. Acquired steady-state absorption and emission spectra reveal that the merocyanine free and bound to cyclodextrin could be used as a polarity probe for DMSO-water binary solutions.

Thandi Buthelezi, PhD, is an assistant professor of chemistry Kathryn Burke, biology major, participated in the research during her senior year as a Wheaton Research Partnerships research assistant. Kathryn graduated in May 2012, and is employed. She is in the process of applying to graduate programs. Caterina Riccardi, a chemistry major, participated in the research during her senior year for independent study credit. She graduated in May 2011 and will start a PhD program in chemistry at the University of Connecticut in fall 2012. The research was supported by Wheaton College.


This study examined self-reported academic dishonesty at a mid-sized public university. Students (N = 492) rated the likelihood they would cheat after agreeing to abide by each of eight honor code pledges before internet based assignments and examinations. The statements were derived from honor pledges used by different universities across the United States and varied in length, formality, and the extent to which the statements included consequences for academic dishonesty. Longer, formal honor codes with consequences were associated with a lower likelihood of cheating. Results showed a significant three-way interaction and suggest how to best design honor codes.

Tiffany is currently in the doctoral program at Marquette University. Tonya starts graduate work at Auburn University this fall.

This study examined the evolution of protective function in the small heat shock protein αA-crystallin. Small heat shock proteins are used to maintain cellular health in many cell types and their dysfunction is related to diseases such as Alzheimer’s, cataracts and cancer. By examining the structure and function of αA-crystallin from six fish species adapted to different environmental temperatures, we identified two amino acid changes that increase this protein’s ability to prevent the aggregation of other proteins. Our results show that a comparative approach can be used for insight into the design of small heat shock proteins with enhanced protective ability.

Mason Posner is professor of biology and chair of the Department of Biology/Toxicology at Ashland University. Jackie Skiba graduated in 2010 and currently works in quality control for the coffee division of the Smuckers Corporation. Amy Drossman graduated in 2011 and is continuing her studies at the Illinois College of Optometry. This research was supported by an AREA grant from the National Eye Institute (R15 EY13535) to Mason Posner.


In this work, the use of mini cantilever beams for characterization of rheological properties of viscous materials is demonstrated. The dynamic response of a mini cantilever beam partially submerged in air and water is measured experimentally using a duel channel PolyTec scanning vibrometer. The changes in dynamic response of the beam such as resonant frequency, and frequency amplitude are compared as functions of the rheological properties of fluid media. Next, finite element analysis method is adopted to predict the dynamic response of the same cantilever beam and then compared with experimental results already performed to validate the FEA modeling scheme. After model validation, further numerical analysis was conducted to investigate the variation in vibration response with changing fluid properties.

Awlad Hossain is an assistant professor of mechanical engineering at Eastern Washington University. Ahsan Mian is an associate professor of mechanical engineering at Montana State University. Luke Humphrey performed the experimental portion of the research at Montana State University (MSU) during the academic year 2010-2011. He did this work was as part of his independent study credit. Luke completed his BS in mechanical engineering at MSU in December 2011. He will start PhD at Georgia Tech in fall 2012.


The present study examined induced repetitive behaviors of rats as a model for aspects of human obsessive compulsive disorder. Rats responded to buspirone with vicarious trial and error behavior and prolonged decision time in the baited T-maze. Adolescent Long-Evans rats were uniquely unresponsive to buspirone. Receptor protein expression and a selective receptor antagonist were used to show that these effects of buspirone were independent of the brain serotonin 1A receptor.

Dennis Rhoads is a professor of biology. Sunaina Kaushal is a medical student at Drexel University and worked for two years on this project to fulfill requirements of the University Honors program. Janine Mallari is in the process of applying to graduate and medical schools and this was her independent study project. Krystal Orlando just finished her sophomore year. She began working on this project as part of the School of Science Summer Research Program and continues doing research for Departmental Honors. She plans to apply to medical school. Research was supported by the department and summer research program, and grants from the Pfizer Undergraduate Research Endeavors Science program and Benjamin Cummings/Metropolitan Association of College and University Biologists.

An electron ionization study on the fragmentation of metastable molecular radical cations of ethyl dihydrocinnamate, several deuterium-labeled isotopomers, and related arylalkanoic acid esters was performed by mass-analyzed ion kinetic energy (MIKE) spectrometry. A highly specific H/D interchange involving the four hydrogen atoms at the benzylic- and ortho-positions was found to occur. This represents another striking case of complete 4H–scrambling that enables the molecular ion to fully equilibrate the interchanging hydrogen atoms prior to fragmentation. A mechanism rationalizing these observations and extending previously suggested mechanisms is proposed involving a series of distonic ions and the intermediacy of an ion/neutral complex. Interestingly, this research was developed from a sophomore-level laboratory course project.

Aaron W. Amick is an assistant professor in the chemistry department at Washington College. Richard R. Hark and I. David Reingold (recently retired) are in the Chemistry Department at Juniata College. Dieter Barth, Matthias C. Letzel, and Dietmar Kuck are faculty members at Bielefeld University, Germany. Edward Hoegg and Sean Harrison worked on this project during the summer of 2010. Edward graduated in May 2011 and is currently working at the Department of Energy. Sean graduated in May 2012 and will be attending pharmacy school. Katelyn Houston worked on this project during the spring of 2011. She graduated in May 2012 and is preparing to begin a PhD program in chemistry at the University of North Carolina-Chapel Hill. This research was graciously funded by Washington College.

Hong R, Kang TY, Michels CA, Gadura N. Membrane lipid peroxidation in copper alloy mediated contact killing. Applied and Environmental Microbiology 2012; 78:6:1776-84. (Queensborough Community College, CUNY)

Copper alloy surfaces are passive antimicrobial sanitizing agents that kill bacteria, fungi, and some viruses. This study explores the hypothesis that nonenzymatic peroxidation of membrane phospholipids is responsible for copper alloy-mediated surface killing in Escherichia coli. Cell survival, lipid peroxidation levels, and DNA degradation were followed in cells exposed to copper alloy surfaces containing 60 to 99.90 percent copper or in a medium containing CuSO(4). Our results suggest that copper alloy surface-mediated killing of E. coli is triggered by nonenzymatic oxidative damage of membrane phospholipids that ultimately results in the loss of membrane integrity and cell death.

Nidhi Gadura is an assistant professor in the Department of Biological Sciences and Geology at Queensborough Community College. All the work for the publication was done at the newly established biotechnology lab at Queensborough in collaboration with Dr. Corinne Michels (Distinguished Professor Emerita) at Queens College. Tae Y. Kang started the project in 2008 as part of the NSF-STEP program and has gone on to complete his PA program and is currently working. Robert Hong took over the project in 2010 as an NSF-REU student and is still enrolled at Queensborough; he plans to pursue a PhD in the near future. The project was funded by a Professional Staff Congress-City University of New York (PSC-CUNY) grant and Copper Development Association grants to Nidhi Gadura.
Toussaint LL, Marschall JC, Williams DR. Prospective associations between religiousness/spirituality and depression and mediating effects of forgiveness in a nationally representative sample of United States adults. Depression Research and Treatment 2012. (Luther College)

This article employs the use of a nationally representative sample of United States adults in examining the extent to which religiousness/spirituality are associated with diagnosed clinical depression across time. Forgiveness was explored as a possible mediator of these associations. Results showed that religiousness/spirituality, forgiveness of oneself and others, and feeling forgiven by God were associated, both cross-sectionally and longitudinally, with depressive status. Further, forgiveness of others acts as a mechanism of the salutary effect of religiousness/spirituality; forgiveness of oneself is an independent predictor.

Loren Toussaint, associate professor of psychology at Luther College, served as the primary faculty advisor for this project. Harvard University professor, David Williams (Department of Society, Human Development, and Health; Department of African and African American Studies; Department of Sociology), also contributed. Then Luther College senior, Justin Marschall assisted on the project. Throughout his time at Luther, Marschall frequently collaborated with Toussaint, contributing to 17 different research projects over the course of two and a half years. Toussaint’s laboratory for the Investigation of Mind, Body, and Spirit, is made up of about a dozen other students. Marschall graduated from Luther College in 2012 with a major in psychology and a minor in music. In August of 2012, Marschall began a PhD program at Iowa State University in social psychology. This study was supported by the Fetzer Institute, Grant T32-MH16806 from the National Institute of Mental Health, and by a Faculty Research Grant from the University of Michigan.