



ON THE WEB

Fall 2014 | Volume 35, Number 1

Undergraduate Research in Support of Sustainability



ALSO IN THIS ISSUE

2014 CUR FELLOWS' ADDRESSES

WEB VIGNETTES:

Sustainability Research Through the Lens of Environmental Ethics

Creating Value Through Collaborative Undergraduate Research Award Programs in Sustainability

Caring for a Shared Place: Undergraduate Research to Restore an Urban Watershed

Sustainability-related, Experiential Learning at McMaster University

Editor-in-Chief

Kelly McConaughay, College of Liberal Arts and Sciences
Bradley University
kdm@bradley.edu

Issue Editors

Janice DeCosmo, Associate Dean Undergraduate Academic Affairs
University of Washington
jdecosmo@uw.edu

James T. LaPlant, College of Arts and Sciences
Valdosta State University
jlaplant@valdosta.edu

Janet Stocks, Office of Academic Affairs
Trinity Washington University
stocksj@trinitydc.edu

Stephen Heinemann, Department of Music
Bradley University
sjh@bradley.edu

Copy Editor

Cheryl Fields
cheryl.fields@verizon.net

Technical Editor

Lindsay Currie
lcurrie@cur.org

Feature Editors

Book Review

Susan Berry Brill de Ramirez, Department of English
Bradley University
brill@fsmail.bradley.edu

International Desk

Mick Healey
Professor Emeritus
University of Gloucestershire
Healey HE Consultants
MHealey@glos.ac.uk

Alan Jenkins

Professor Emeritus
Oxford Brookes University
alanjenkins@brookes.ac.uk

Undergraduate Research Highlights

Marie Graf
School of Nursing
Georgia Southern University
annennis@georgiasouthern.edu

2014-2015 Divisional Editors

Arts and Humanities

Iain Crawford, Department of English
University of Delaware
icrawf@udel.edu

At-Large

Carl Wozniak, School of Education
Northern Michigan University
cwozniak@nmu.edu

Biology

Lonnie Guralnick, Department of Mathematics & Natural Sciences
Roger Williams University
lguralnick@rwu.edu

Chemistry

Alex Norquist, Department of Chemistry
Haverford College
anorquis@haverford.edu

Engineering

Binod Tiwari, Civil and Environmental Engineering Department
California State University, Fullerton
btiwari@fullerton.edu

Geosciences

Laura A. Guertin, Department of Earth Science
Penn State- Brandywine
uxg3@psu.edu

Health Science

Niharika Nath, Life Sciences Department
New York Institute of Technology-
Manhattan Campus
nnath@nyit.edu

Mathematics and Computer Sciences

Ben Ntatin, Department of Mathematics and Statistics
Austin Peay State University
ntatinb@apsu.edu

Physics and Astronomy

Sorinel Oprisan, Department of Physics and Astronomy
College of Charleston
oprisans@cofc.edu

Psychology

Amy Buddie, Department of Psychology
Kennesaw State University
abuddie@kennesaw.edu

Social Sciences

Laurie Gould, Department of Criminal Justice and Criminology
Georgia Southern University
lgould@georgiasouthern.edu

Undergraduate Research Program Directors

Sumana Datta, Department of Biology
Texas A&M University
sumana@tamu.edu

Publisher

CUR National Office
Council on Undergraduate Research
734 15th Street NW, Suite 550
Washington, DC 20005-1013
Phone: 202-783-4810
Fax: 202-783-4811
www.cur.org

Design

Design and Prepress Production
SliceWorks
Gaithersburg, MD
www.slice-works.com

The Council on Undergraduate Research Quarterly is published in the Fall, Winter, Spring, and Summer by the Council on Undergraduate Research.

The mission of the Council on Undergraduate Research is to support and promote high-quality undergraduate student-faculty collaborative research and scholarship.

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

CUR Advertising Policy

The Council on Undergraduate Research accepts advertising from organizations and individuals if such ads are in line with our tax-exempt educational purpose, which is to promote undergraduate research and education. We retain the right to refuse any advertising that we feel does not fall within our guidelines.

For more information, contact the National Office at cur@cur.org or 202-783-4810.

Subscriptions

For CUR members, the *CUR Quarterly* is delivered as a benefit of membership. For other individuals, the annual subscription rate is \$42. For libraries, the subscription rate is \$87 annually.

To order a subscription, visit: www.cur.org/publications.html.

ISSN 1072-5830

Council on Undergraduate Research
734 15th Street NW, Suite 550
Washington, DC, 20005-1013

Cover Photo:

Calvin College biology students collect water samples to test for bacterial contamination of Plaster Creek, a highly degraded urban stream in Grand Rapids. (Photo credit: Dave Warners)

CONTENTS *Fall 2014 Web*

Undergraduate Research in Support of Sustainability

Special Features

CUR Fellow’s Address: Undergraduate Research-Career Stages and a Challenge Ahead for CUR 4

—Mark R. Brodl

CUR Fellow’s Address: Undergraduate Research as a Life-Changing Activity 9

—Mitch Malachowski

Departments

CURQ Web Vignettes 14

Sustainability-related, Experiential Learning at McMaster University

—Kate Whalen, Melissa Gallina

Sustainability Research Through the Lens of Environmental Ethics

—Daniel Fouke, Sukh Sidhu, Robert Brecha

Creating Value Through Collaborative Undergraduate Research Award Programs in Sustainability

—Lynnette Overby, Roger Strong, Jr., Mark Christel, Gretchen Sneff, Gregory McKinney, Rebecca Maniates

Caring for a Shared Place: Undergraduate Research to Restore an Urban Watershed

—Gail Gunst Heffner, David P. Warners

Undergraduate Research Highlights 21

CURQ on the Web, Fall 2014 edition
http://www.cur.org/publications/curq_on_the_web/

CUR Fellow's Address

Mark R. Brodl, *Trinity University*

Undergraduate Research-Career Stages and a Challenge Ahead for CUR CUR Biennial National Conference, Washington, D.C., June 29, 2014

The CUR Fellows Awards have a wonderful history. They've recognized some of our nation's finest undergraduate research mentors but many others await recognition and (gratifyingly) more are queuing up each year as their careers mature. I remember when Jon Monroe (James Madison University) led me and others who were CUR Counselors at the time in an effort to bring forward to the CUR General Council a proposal for the establishment of the CUR Fellows Awards. It was a great idea. But I didn't believe I'd someday be among the awardees. And I am truly, deeply honored to be named a 2014 CUR Fellow. Since learning of the award, I have reflected upon my experiences in undergraduate research over the last three decades. And I've found that my students, colleagues, administrators, and even reviewers for manuscripts and grant proposals have been essential in shaping my career, making me stretch intellectually, and making what some call "work" so completely gratifying and enjoyable. In my address today I would like to highlight some of the stages I've experienced in my career and also look forward to a challenge that also presents an opportunity.

Stages

Assistant Professor—The Establishment of a Research Program. At the beginning of my career at Knox College, I was (necessarily) focused on the establishment of my research program. At the beginning, I didn't fully appreciate the difference between a research program and research projects, but four factors were key in my building a deep understanding of the distinction. First of all, I had colleagues who led by example. Among them was the late Billy Geer who had, since 1968, sustained an externally-funded research program that supported undergraduate research experiences. Bill encouraged me to think about my research agenda in broad terms. And while he supported me in seeking small pots of money to get my lab going, he also encouraged me to submit a more comprehensive proposal to the National Science Foundation's Research at Undergraduate Institutions (NSF-RUI) program. The preparation of that grant proposal was the second key factor in reaching my understanding of what it meant to build a research program. The exercise of proposal writing has been one of the most powerful faculty development experiences of my career. Grant proposal writing provides a planning tool to structure the trajectory of a *program* of research, and

within the context of that program undergraduate research projects are strategically defined to advance a research agenda. Students benefit hugely from such a structure. Their work is embedded in a larger context. The work they do is shaped by the work of others who had come before them, and it leaves a legacy upon which students after them will build. It's seemingly simple, but it's also very profound. I learned later that a relatively "upstart organization" called CUR had been instrumental in making NSF's RUI program a reality. I joined CUR and found the third key factor in my development as an undergraduate research mentor, a nationwide community of scholars devoted to undergraduate research. As a new faculty member, I learned a great deal from CUR colleagues and made strong friendships that continue to strengthen me today. CUR's mission is as relevant now as it was back in 1988, and toward the end of my talk I will suggest how it could be even more important in the future.

I want to note that sustaining a vigorous undergraduate research program is no small task. But I believe it is our students who make the work so deeply rewarding. I thrill to the moments when a student in lab says, "Oh," and with that simple word you realize that hundreds of hours of classroom instruction have suddenly taken on deeper significance and meaning. I also thrill to watch my students present at a national or regional professional meeting as they realize that their work is of great interest to others and that they can speak with a voice of authority and ownership. Once, after one of my students gave a talk at a national meeting, I had a PI come up to ask me when my student might start looking for postdoc opportunities. I told him my student was just an undergraduate, and he asked how I was able to get my students to do this level of work. I responded (somewhat stunned) in the only way I could: I told him "I never tell them they can't." I was fortunate that Knox (and now also Trinity) highly values undergraduate research. The infrastructure is there. The financial mechanisms are there. There is a culture of involving students in research and mechanisms such as independent studies and honors projects recognize that participation. So the fourth key component is capable and energizing students, coupled with an institution that "gets" how to support the enterprise.

Associate Professor—The Departmental Context. I knew from both personal experience (I had done independent study

and an honors project at my *alma mater*, Knox College) and from what I witnessed in students in my research group that undergraduate research was a singularly powerful learning experience. After securing tenure I became department chair within a couple of years, and as chair I led an effort to make undergraduate research experiences more broadly available to our majors. Our approach was to build undergraduate research into the curriculum systemically. We installed a required BIO 211: Introduction to Research course that focused on hypothesis building, experimental design and testing, data analysis, and communicating findings. Importantly, BIO 211 ran experiments iteratively, allowing students to learn from their mistakes (rather than be penalized for making them). After completing this course, students were required to select an advanced research methods course that introduced them to high-end instrumentation and investigative techniques used in our research programs. These courses also repeated the emphases on hypothesis building, experimental design and testing, data analysis and communicating findings. Our goal was to help students make what we called the teaching laboratory-to-research laboratory transition. After taking one of these courses students completed a research project (or an Honors project) in one of our research groups. In addition, the lab sections of our regular course offerings were investigative, and they introduced students to key experimental models and research methods used among our department's research groups. Now it doesn't sound much like innovation, but in the mid-1990s we were ahead of our time. Strong undergraduate research programs were essential in realizing our goals; they were the foundation, and they made sustaining the undertaking manageable.

Full Professor – Cultivating Undergraduate Research across STEM Disciplines. In 2001, I moved from Knox College to Trinity University. My new position came with course reductions and research support, as well as the expectation to “make a difference” at the university. I knew many of my new colleagues already from interactions in professional societies, many of them CUR-based. I knew Trinity had a strong tradition of undergraduate research upon which I could build, and at the time the National Academies of Science’s “Bio 2010” and other publications were calling attention to the national need to break down traditional disciplinary boundaries and create interdisciplinary linkages to better prepare students to meet 21st century challenges. The “difference” I proposed to make was to work with my colleagues to lead a series of efforts to build interdisciplinary research and curricular linkages. Over the course of several years we have been fortunate in securing multiple grants from several funding agencies, including NSF, Sherman Fairchild, Merck-AAAS, the W. M. Keck Foundation, Howard

Hughes Medical Institute, the Beckman Foundation, and others. The quality of the linkages we built in those externally funded programs was directly related to the strength of the research efforts that supported them. For example, we had initially built a minor in biological mathematics. External funding supported curricular development, including some rather novel math modeling courses that included “wet lab” sections, which served to generate data for modeling and also provided learning experiences in biology for math majors. But the quality of the lab experiences and the overall strength of the major were fortified markedly by a subsequent grant that supported research collaborations that deepened the intellectual ties among biologists and mathematicians. Similarly, students working on collaborative projects in research groups working across disciplines put to use new instruments acquired with the external funding, and their capabilities and achievements guided the development of interdisciplinary learning experiences for our teaching laboratories. I want to point out that very often it was our students who made the research collaborations work. For example, a research student I shared with a math colleague was able to make the mathematical details of our modeling project comprehensible to me (the last time I put my calculus neurons to work at that level was some 35 years ago!). Reciprocally, her understanding of math and biology allowed her to intuit where my math colleague was struggling to understand the cell biology in our project, allowing her to make key connections precisely where they were needed. So research efforts with students can be powerful in providing the scaffolding for strategic initiatives to link departments across a division. Remember, you never tell them they can't!

Administration – Institutional and National Contexts. After nearly a decade at Trinity, I had the opportunity to serve as a “rotating” program director for the Integrative Organismal Systems Division in NSF’s Biology Directorate. While there, I was challenged to think about supporting research broadly and developing the capabilities of individual scientists as well as subdisciplines within my field. While there, I pushed hard to make scientists aware of NSF programs that supported undergraduate research, stressing the importance of proposal pressure for the health of NSF-RUI (a program that was influenced significantly by efforts from CUR), Research Experiences for Undergraduates supplements (REUs are supplements to NSF awards that provide funding for investigators to incorporate undergraduates into their work), and Research Opportunity Awards (ROAs are programs for investigators at Primarily Undergraduate Institutions [PUIs] to conduct research in the laboratory of an NSF-funded scientist). I also emphasized at NSF the importance of using PUI investigators as *ad hoc* reviewers, panelists, and

rotating program directors, and recruited PUI investigators as reviewers for other programs in the Bio Directorate as well.

My NSF experience encouraged me to further explore an administrative role in academia, and upon my return to Trinity two years later, I moved to my current position as Associate Vice President for Academic Affairs–Budget and Research. I have since been working to diversify our undergraduate research efforts beyond their traditional strongholds in STEM disciplines. Some simple efforts have included grant-writing workshops built on the CUR Institute model and extending the concept of start-up funding to include artists, humanists, and social scientists (for example by providing support for student summer researchers to work with a new hire on a project within their scholarship/creative work). I have encouraged conversations among scientists and artists/humanists—not to impose the STEM model on their disciplines, but to prime thinking and explore what might be adoptable or adaptable. We participated in a CUR Institute on Undergraduate Research in the Arts and Humanities, and this led to a successful proposal to the Mellon Foundation to support the integration of research into the curriculum as well as summer undergraduate research opportunities linked to faculty research agendas. Importantly, Trinity has made a commitment to endow these research opportunities after Mellon funding has expired. Our first Mellon SURF students did some exciting work. For example, a student with complimentary interests in computer science and classics went to Turkey with a Latin professor who studies shipwrecks on the floor of the Mediterranean to uncover lading patterns that provide insights into ancient trade routes and cultures. His computational skills helped them build a new approach to predicting lading based on debris fields and local sea conditions. In another example, a music major with interests in Chinese language worked with a member of our music faculty in Taiwan to research the staging of an opera in preparation for producing it both in Taiwan and later back at Trinity. I find that at this stage in my career my accomplishments increasingly are measured in how I can align and make available resources to support scholarship and learning—and first among them is supporting student-faculty research collaborations.

So I've found that an academic career undergoes a maturing process that moves from one focused on "my research" and "my classes" to the research programs and curriculum of a department, a division, and then to the institution and, sometimes, beyond. I believe this is the case for faculty development broadly but for furthering undergraduate research it seems especially salient. I also believe it's important for an individual faculty member to be aware of one's own place on that trajectory over time and to ask whether one is

making appropriate and mission-advancing contributions. It echoes the famous "Ask not what your country can do for you" motif.

Challenges Ahead

I would like now to present what I see is a challenge for higher education but an opportunity for CUR and undergraduate research. Colleges and universities have come under scrutiny for very high and seemingly ever-rising costs. In the media, it is reported that tuition and fees have risen far faster than family incomes, but at the same time, students who earn degrees find it increasingly difficult to secure jobs after graduating. For example, according to an August 2012 Bloomberg report average college costs rose by a whopping 1,120 percent since 1978 while median family income rose a mere 8.7 percent over that same period. And according to a June 2014 EPI report 16.8 percent of recent college graduates are underemployed and 8.5 percent are unemployed (that's compared to 3.3 percent unemployment for college graduates overall). It doesn't help when billionaires such as Bill Gates and Mark Zuckerberg point out that they are college dropouts. Reports like these are numerous and have led to a perception that the ivory tower disconnect-from-reality is far, far worse than ever.

For those of us in the tower, we know the real story is more complex than what is presented in the sound bites. The more informative point for comparison is the net price for a college education. From 1996 to 2011, the average net cost for tuition and fees at private four-year colleges increased in constant 2011 dollars by \$2,000 (from nearly \$11,000 to nearly \$13,000, an 18 percent increase), and at public institutions that increase was less than \$600 (from nearly \$2,000 to just over \$2,500, an 30 percent increase) (Hardcastle 2012). These are increases, but they aren't as hair-raising as those reported in the media. In fact, when you look at costs in more recent years (as institutions have responded to concerns about increasing costs), the net cost of attending a private, 4-year college actually *decreased* by \$550 from 2006 to 2011 after adjusting for inflation (Hardcastle 2012). For a number of reasons (endowment resources, state aid, federal grants, etc.) the comparable data for public institutions are difficult to generalize, but even there inflation moderates cost increases over this period significantly.

So the more complex message is, yes, college costs have risen, but the increase is not so nearly out of line as otherwise reported. And in the marketplace of good buys, a college education remains a good investment (contrasted, for example, with the purchase of a new car, which had an 18 percent increase in the median transaction price from 2003 to 2013, according to a 2013 report in *USA Today* (and cars

decrease in value over time!). Bill Gates and Mark Zuckerberg are exceedingly rare exceptions, rather than the rule.

But in the meantime, the “story” of increasing college costs has prompted calls to hold colleges and universities accountable. President Obama’s administration called for measures of college quality, including metrics such as graduation rates, employment rates for graduates, salaries for graduates, numbers of students gaining employment in their fields upon commencement, etc. (Jamrisko and Kolet 2013). Whether this will be at a national or state level is part of the conversation (Jamrisko and Kolet 2013). The reaction from colleges and universities has been mostly negative, with presidents and boards pointing out the shortsightedness of such approaches.

So why is all of this important to undergraduate research and CUR? As the value of higher education is called into question, colleges and universities are left struggling to find compelling responses. This is a time when cooperation rather than competition should be part of the response. But that’s not the way we’ve been operating (we’ve all heard about the arms race to build dormitories, student support services, sports facilities, food courts, etc., to attract and retain students, and by some measures this has been done by passing on the costs to incoming students and their parents/guardians). I strongly feel that CUR can be a point for coordinating a cooperative response that can help change the national discourse.

I know I am preaching to the choir when I state that undergraduate research is arguably the most powerful learning experience available. Yet there are shockingly few resources documenting its outcomes. A search on “value of undergraduate research” provided over 8 million citations, yet of the first 182 cites (from this millennium) only one of them is in the popular press (a 2010 *Huffington Post* article by James Gentile on David Lopatto’s *Science in Solution* (there is but a single comment on the article, and it’s negative). The vast majority of these citations bring up pages written by individual colleges and universities or academic journals. I also spent several hours searching on the web for undergraduate research and college search advice. Here is what I found:

- Search engines (Cappex, Peterson’s, CollegeBoard, College Navigator, College Data, ACT College Search, and the federal government’s IES College Navigator) that prospective students and parents/guardians can use in searching for colleges don’t discuss undergraduate research (it’s never a tick off option for a search)

- Advice blogs (15 of them searched) don’t mention undergraduate research
- College counselor sites don’t mention undergraduate research (frankly, what they do mention is quite frightening!) (20 searched)

Working with undergraduate researchers and their faculty mentors, CUR can collect compelling outcome data to document the value of undergraduate research. Those data can be used as follows:

- *Bring undergraduate research forward in the public’s consciousness.* Use the data to inform the public discourse through media attention, outreach to schools, information to college counselors, data provided to bloggers, etc.
- *Use outcomes to develop metrics.* If outcomes scorecards are to be developed for determining institutional effectiveness, this is an opportunity to advance undergraduate research as part of what the nation values in higher education.
- *Leverage outcomes to support funding for undergraduate research.* In the 1980s CUR influenced NSF and NIH to begin programs to support the funding of undergraduate research (with the development of RUI and AREA, respectively). That influence involved the education of scientists and foundation administrators and also convincing Congress that undergraduate research was a priority worth funding. I believe it is time again for CUR to take on a major effort to educate. This time, in addition to STEM fields, CUR should advance arguments to support funding for the arts, humanities and social sciences to reflect our expanded mission.
- *Provide talking points for colleges and universities.* If undergraduate research rises in importance, this helps to focus institutional resources on supporting undergraduate research. The structure used to gather data can influence how undergraduate research programs at individual institutions are constructed. The outcomes can be used by institutions in student recruiting.

I would argue that CUR is well positioned to take on such an effort. First of all, CUR has experience in collecting data for large studies. Back in the 1990s CUR Directories (NICUR) collected data on undergraduate research programs in STEM disciplines. Most of these data were focused on facilities and

faculty productivity, rather than on undergraduate research outcomes. But the point is, CUR has done this before. The information was collected through onerous surveys done by regular mail, but CUR has matured and so has the internet. In addition, program assessment is vastly more pervasive and sophisticated now than it was back then, and institutions understand the value in participating. Data collection should be markedly easier now.

As a vehicle to gather data, I note that CUR already has in place the Registry of Undergraduate Researchers. It is currently designed as a forum for undergraduates to showcase their credentials to prospective graduate schools. With some thoughtful modification it could also be used to gather the appropriate data for this broader effort. Ideally, this would include a mechanism for the gathering of longer-term outcomes. Undergraduate mentors have strong ties to their former students, and these could be leveraged to obtain the longer-term data. And, as I pointed out earlier, the types of data collected could be influential in shaping undergraduate programs at institutions across the nation.

So as colleges and universities grapple with the challenges ahead, I see a nice opportunity for CUR to make some strategic gains to further enhance its significance.

In closing, I again want to thank CUR for this fine honor and my students, colleagues, and collaborators who helped

so very much in making this possible. Thank you for your attention and for indulging me.

References

Economic Policy Institute. 2014. "The Class of 2014." <http://www.epi.org/publication/class-of-2014/>.

Gentile, James M. 2010. "Science Education: The Value of Undergraduate Research." *Huffington Post*, March 8. http://www.huffingtonpost.com/james-m-gentile/science-education-the-val_b_490057.html

Hardcastle, Valerie Gray. 2012. *The Academic Arms Race, New Individualism, and Deaning*. CCAS 2012 Presidential Address, McMicken College of Arts and Sciences, University of Cincinnati. www.ccas.net/i4a/doclibrary/getfile.cfm?doc_id=317

Healey, James R. 2013. "Report: Average Price of New Car Hits Record in August." *USA Today*, September 5. <http://www.usatoday.com/story/money/cars/2013/09/04/record-price-new-car-august/2761341/>

Hechinger, John and Roger Runningen. 2013. "Obama Proposes Linking Federal Aid to New College Ranking." *Bloomberg News*, August 22. <http://www.bloomberg.com/news/2013-08-22/obama-said-to-propose-tying-college-aid-to-school-ranking.html>.

Jamrisko, Michelle and Ilan Kolet. 2013. "Cost of College Degree in U.S. Soars 12 Fold: Chart of the Day." *Bloomberg News*, August 15. <http://www.bloomberg.com/news/2012-08-15/cost-of-college-degree-in-u-s-soars-12-fold-chart-of-the-day.html>.

Mark Your Calendar with Important National Conference on Undergraduate Research 2015 Dates

Eastern Washington University

April 16-18, 2015

Student Abstract Submissions Accepted:
September 29 –
December 2, 2014

http://www.cur.org/ncur_2015



CUR Fellow's Address

Undergraduate Research as a Life-Changing Activity

CUR Biennial National Conference, Washington, D.C., June 29, 2014

I am humbled to be here receiving this award, especially because I could rattle off the names of a dozen or more CUR people who are deserving of this award. In any case, though, you are stuck with me for the next 40 minutes and I hope you enjoy the ride. Let me begin by thanking some people. First, my wife Beth and my daughters Michelle and Erica. You are my great loves. And secondly, my students who enrich my life every day and make me come to work rather than playing golf or going to the beach. I will start by talking a little bit about my own professional journey, discuss my research program, make some arguments I have made over the years on the importance of undergraduate research, and follow this with some commentary on what I think CUR is all about and what it has meant to me.

1. My Journey

Simply put, I love to teach and work in my lab, and I love to work with students. I am dedicated to student success and student outcomes, and this dedication shapes both my teaching style and my research agenda. Where did these feelings come from? Well, primarily, I am motivated by my memories of being an undergraduate student. I can still remember how I was very unsure of what I was most interested in and what I wanted to do with my life. I knew only that I loved to read, to solve puzzles and to think broadly about issues. Yet, I had no sense of where those interests might take me or what might be best for me. That changed when my organic chemistry professor, John Williams, at Rhode Island College asked me to do research with him in his lab. Suddenly, overnight it seemed, everything changed. I had a focus, a clear picture of what I most enjoyed, and a sense of what my future might hold. Now, that is *my* story. There is another perspective to the story and it comes from that organic chemistry teacher and undergraduate research director at Rhode Island College, John Williams. He speaks of the unformed me, the one who was a little less developed. Here is what he said to me in a recent communication:

Mitch:

The pre-enlightenment encounter with you that sticks is an encounter on the second floor of Clarke Science in a crowd of students changing classes. I think you were then currently in my organic class. You looked hung-over, staring blankly off into the distance "dressed" in a "fashion" that was a

stretch even for undergraduates at the time really old jeans, ripped up sneakers and a WWII-vintage ripped, worn, and faded olive drab fatigue jacket, with Jesus-length hair and beard commensurate with your wardrobe: totally disheveled. All I could think to say as I stopped you and (sort of) got your attention was: "Malachowski, when are you going to get off your ass?" You gave me a puzzled look-I don't remember if you gave me an answer — it was a tough question for a pop quiz — and continued on down the hallway.

While hesitant to assert the logical fallacy of a post hoc propter hoc argument, that event seemed to mark a turning point in your, well, getting off your ass.

I remain, with fond regards, a proud mentor
John

Well, this experience did much more than simply shape my intellectual life. It also showed me the powerful impact a professor can have in helping a student find direction and purpose in life. To this day, I can say that at least once a week I find myself reflecting in some way back to my own undergraduate experiences and applying the lessons I learned then in interactions with my own students. And yes, I got a new wardrobe, cut my hair, and shaved and here I am.

2. My Research Program

I view myself as both an educator and a scientist, and I think that these two facets of my professional life are intimately intertwined. My research efforts are of two types: the first is experimentally driven and revolves around the synthesis of novel compounds that can be used for a variety of practical purposes, while the second focuses on exploring the role of faculty research at undergraduate institutions and its impact on students and student learning.

First, let me talk about the chemical side. There are many different types of chemistry and many different kinds of chemists. Some like to perform calculations, some study biological systems, some prefer to study the interaction of molecules with light, while others relish synthesizing new molecules. By training I am a synthetic organic chemist so I am interested in the preparation of new molecules. The act

of creation, whether in the laboratory or through the baking of one's own bread, in the building of a house or in the creation of a painting, seems to me to be one of humankind's innate desires. This adaptation of nature by chemists has been a driving force for many new, and oftentimes improved, aspects of our lives.

Let me tell you another story. Before I went to the University of San Diego in 1984, I taught at Gettysburg College and during my time there, I wrote a grant proposal to the Research Corporation that, amazingly, was funded. When I look back at the quality of the writing in that proposal, I have a good laugh, but I like to think that I have come a long way since that time. However, in rereading that proposal, one thing does stand out to me. It is still one of the best research ideas I have ever had. Let me give you a little background. In the early 1980's, there was a great deal of interest in binding small molecules or ions within cavities. This was being pursued for many reasons, including an interest in extracting metals from the environment. The most common molecules being used as the host were crown ethers that had oxygens that could coordinate to ions such as Na⁺ or K⁺. There also were a small number of hosts that could bind negatively charged ions called anions. In my grant proposal, I intended to bind anions and cations within the same host as I was interested in binding molecules that had both a negative end and a positive one with the most common example being amino acids. The Research Corporation liked the idea, and we worked on it for about a year until one miserable day when I was reading the literature and discovered that the French chemist Jean Marie Lehn and his army of post-docs and graduate students had done exactly what we had proposed. And of course, with all his resources, he also was able to not only show how to do it, but was then able to make a series of compounds that made ours superfluous. So out of necessity, our research moved into new areas. And we have been scooped at least twice since.

But of course, there is a lesson in all this and that is, at PUI's, we should sometimes get scooped. I learned from those who came before me in CUR, that our aspirations should be to do research that is cutting edge. That we should be competing in the intellectual realm of our disciplines at the highest possible level, that we should not simply be dabbling in our fields, that we should not settle for "research-lite." And in doing so, we will be competing with those with many more resources and person power. And it certainly will take longer to do what we want to do, but we should still be competing in the world of cutting edge ideas. I take a perverse pleasure in having been scooped by Professor Lehn as he was awarded the 1987 Nobel Prize in Chemistry for his work on molecules that serve as hosts for guest molecules. I was in Stockholm just last week giving a talk, but regrettably, it was not at the

Nobel Prize ceremony. But they did let me pay to go and visit their museum.

In the past five years or so, I have returned to my Gettysburg roots and have been working on molecules that can capture other molecules in their cavities in very different ways than the crown ether type macrocycles do. The molecules we now make are called metal organic frameworks, and they bring together the best of what we know about organic molecules, as well as what happens when they coordinate to metal ions. This field of chemistry is one of the fastest growing areas of chemistry because of the potential use of these compounds for catalysis, materials, and in nanotechnology. The progression from the nucleus, the atom, and the molecule to the supramolecule represents steps up the ladder of complexity. In essence, we make a collection of mononuclear species and then link them together into complex molecular arrays.

We have made some nice contributions to this field in a relatively short amount of time through our pioneering work with compounds called dipyrrromethenes. Once we make the organic portion, we bind it to one metal such as cobalt and then add a second metal (silver) to make the metal organic framework. We are now in the process of trying to bind other molecules in these cavities.

3. Undergraduate Research and Its Connection to Student Outcomes

Along with my chemistry research, my research program also involves probing the role of faculty research and scholarship at PUI's. In this work, I ask questions such as why we engage in research at PUI's; what are the positive outcomes for the faculty, departments and institutions; what are the impacts on students; and how do we manage the monumental changes occurring at our institutions related to the new expectations towards scholarship. I have published some 25 papers in this area, but today I would like to probe three issues that I have considered over the years.

One of the most dramatic changes that has occurred on our campuses over the past 25 years has been the increased expectations for faculty to engage in original scholarship that leads to publishable results. We have reached the point where for many faculty, it is hard to remember a time when faculty didn't embrace a "teacher/scholar" model. But of course this was not always the case. Universities have adapted, changed, and evolved since John Henry Newman wrote in 1852:

"a University ... is a place of teaching universal knowledge. This implies that its object is ... the diffusion and extension of knowledge rather than the advancement. If its object were scientific and philo-

sophical discovery, I do not see why a University should have students." (Newman, 1947).

When I began my faculty career, the great faculty divide was between those who did research and those who did not. Much angst and many wrung hands later, this is no longer the case. With large numbers of retirements and the hiring of many new research-active faculty, at many institutions nearly all of the faculty are now engaged in research activities.

However, I believe that there is a great cultural divide that has sprung up around how groups of faculty spend their time and the goals of their research activities. The new line of demarcation that differentiates the faculty is no longer between those who do and those who don't, but instead is between those who engage students in their research and those who do not. *The fundamental purposes of research using these two models is quite different.* For faculty who engage in undergraduate research, one of the main goals of their research is its impact on student learning. So, let me be as clear as possible. I believe that there is a wide chasm between many faculty on our campuses when it comes to the goals of his or her research. And if a faculty member doesn't believe that one of the goals of his or her scholarship should include having a positive impact on student learning and student outcomes, he or she will not engage in UR activities.

So why do I feel so strongly about this point, that research should be pursued that has a positive impact on students and student learning? I am still concerned that PUI's are evolving into miniature versions of PhD granting institutions, even though PUI's have very different missions. For many years, I have written and discussed the importance of student-centered approaches to scholarship and have discussed the negative consequences of research that does not include students. Let me briefly summarize those arguments by using the language of Alexander Astin, who has shown that the faculty's research orientation versus their student orientation reflects not only how they spend their time, but also their personal goals and values and their interest in and accessibility to students. Simply put, as more and more faculty at PUI's spend more and more of their time engaged in research that does not include students, there is a tremendous shift of faculty from the student-oriented camp to the research-oriented camp. Astin (and a number of other researchers such as Pascarella) have shown that the extent to which faculty are student-oriented has tremendous positive impacts on student satisfaction, learning, and affective development.

The flip side is that when faculty are research-oriented and do not involve students, there are severe negative

consequences on student outcomes. Does anyone really believe that as we move to a model of faculty research that does not include students and student learning as one of its goals we can somehow elude these negative outcomes? I don't believe this is possible, and I believe we need to own up to the risks involved in our campus-wide teacher-scholar models. There are many who disagree with this contention, but I challenge each and every one of them to a duel at 20 paces. No weapons are allowed, only the facts and data supported by the literature. I guarantee that this is a fight I can win every time because of the fine work of the people I just mentioned. My call then is for us to not only reflect on what impact our research is having on our disciplines, departments, institutions, and careers, but to also ask what it is doing, both positive and negative, to our students and student learning. In departments or disciplines where faculty are research-active but don't involve students, they are having a negative impact on students.

So I contend that we should consider an alternative mission statement for research at PUIs:

"Research performed on our campus is pursued primarily as a means to enhance the intellectual climate and for its positive impacts on student learning. In order to directly impact students, all faculty in all departments involved in scholarship should include students in their work. Secondary benefits to the faculty and the institution are also of importance, but enhancing student learning is of primary importance. Decisions regarding hiring, resource allocations, faculty loads and rank and tenure decisions will be determined primarily by the impact of the research on student learning."

What is CUR's responsibility in all this? What is our role in all of this? I think that CUR needs to continue to be vocal in speaking to broader institutional and professional issues, rather than serving as a one-issue organization. As we've matured as an organization, we have taken on more responsibilities for helping shape our institutions in ways that go beyond simply embedding more research on our campuses. We need to continue to speak out on the importance of a research-rich curriculum and the centrality of teaching at all institutions. I am very biased here, but I believe that PUIs are still in the best position to serve as models for all that higher education can be, and I am advocating that we ensure that the correct balance is maintained between our professional activities so that we continue to satisfy the needs of our students, faculty and institutions.

4. CUR

Let me shift and make a few comments about CUR as an organization. First, a quote:

“This party comes from the grass roots. It has grown from the soil of the people’s hard necessities.”

This coining of the term “grassroots,” from Albert Beveridge’s speech at the 1912 Bull Moose Convention in Chicago, was part of the origins of Teddy Roosevelt’s Progressive Party. Well, a CUR national conference probably has little in common with the Bull Moose Convention (although you can fill in your own joke here) except for the mutual description of each group as being “grassroots” in nature. CUR was founded in the mid-1970’s as a grassroots organization, one that sprang from the soil (minds and hearts) of a group of faculty members who had a passion for their work and engaging their students in the laboratory. On the surface, much is different about CUR compared to how we were in our formative years. We began as a small group of chemists from liberal arts colleges and expanded into other natural science disciplines, math, and engineering and then into the social sciences. We brought in those from public institutions and some from PhD granting institutions. We have welcomed grants officers and directors of undergraduate research programs. We instituted a national office, originally at UNC-Asheville, and now in Washington, DC. We are bigger (over 10,000 members) and we include numerous disciplines, with people from almost the entire spectrum of higher education. We even have connected with faculty and institutions in Canada, Australia, and the UK among other countries.

So what of our grassroots nature? Have we discarded it? Well, not really. Our national office and its staff are real treasures, but one indication that we do retain our grassroots character can be gleaned by going to the CUR website. If you look at the list of programs that we offer, you will certainly be looking at a list of ideas that originated in the minds of individual CUR members. Whether you look at the consulting service, mentoring network, the speakers bureau, CUR Institutes, the *CUR Quarterly* or almost any other offering, you will find embedded in the program one or more CUR volunteers. The list is telling in that it shows that the power of CUR is still embodied in its members and I hope that this remains the case.

Certainly there is a complex structure to the organization, with many moving parts. But at its core, CUR is a group of people, a group that is committed to their research and their students and students’ learning. CUR is a community and

indeed, it is a grassroots community where initiatives spring forth and are replicated and enhanced across the country.

In many ways though, CUR serves as a faculty development organization and certainly as a support group for faculty. I recall my first CUR meeting in 1990 at Trinity College in San Antonio. I was amazed at the talks and workshops and plenaries I attended, as I felt a deep kinship for the ideas and approaches being discussed. But of course, what was most striking were the people and their interest in sharing with me much of what I was trying to build in my own research program. And it was invigorating to interact in deep conversations about what really matters to our students and to us with so many people from other disciplines. The CUR spirit of sharing and collaborating was a welcome respite from other professional meetings where competition and one-upmanship were at their core. The early CUR values still permeate the organization and it clearly is evident in the proceedings this week.

More than anything, CUR is an expression of our shared culture and shared values. In many ways, UR makes a statement about what we value—curiosity, academic rigor, striving for understanding, pushing ourselves beyond the here and now, and our interest in being both teachers and practitioners-teacher/scholars. May these ideals live a long and prosperous life.

5. It is Very Much About the Students

If there is one thing that I have kept in the front of my mind all these years, it is how hard it really is to be a student. I remember the confusion I had in trying to decide who and what I wanted to be as an undergraduate and where I wanted to go with my life. I lived in a dorm with amazingly unmotivated, party-loving mates; I played on the basketball team; I had a job; I loved doing science. And I was living away from home for the first time. It was hard to be focused and it was hard to be consistent and it was at a time when we were nowhere near as career-oriented as students are now. And compared to parents now, our parents largely left us to our own devices. So, I believe the best thing that all faculty could do is to put themselves back in the world of being a student and try to learn something new. Try to learn how to play golf or play the guitar or learn a foreign language. Take lessons and see what it is like to be a student again. See how focused you are and how consistent you are and see how hard it is to do the homework as you balance your life. In doing so, you will get a taste of what our students experience every day. And they are doing it with coping skills that are much less developed than ours.

6. The Future

I've never been known as a seer or a prophet but I would like to comment on what I think the future of undergraduate research might look like. First, it will be institutionalized on most of our campuses. This is not an easy task, but I say this with some confidence as I have worked with over 400 institutions interested in doing this very thing, and I see the internal and external drivers in place for this to happen. External calls from employers for students to have better problem solving and critical thinking skills are driving some of this. And so are state legislatures and funding agencies and other professional societies. Internally, connecting UR with other high-impact practices and the power that goes with that collection of activities has really taken hold on our campuses.

There also is growing interest in linking UR with internationalization efforts and community-based research activities in ways that bring out the best in all of these. And there is still an interest in using UR as a way to enhance admissions of high quality students and for retention of students from many different backgrounds. These efforts speak to the importance of our endeavors. The days of UR as a boutique program offered for only the best and brightest and honors students is now in our past. Egalitarian approaches to our work are now carrying the day. So the challenge for us is how to engage that vast variety of students and student types and support them with high quality experiences that speak to how they are and where they came from.

What of the activity of UR itself? Will it change? We have never really definitively agreed upon what UR is and what it isn't. And in many respects, we don't need to come to a consensus. But as practitioners from many different backgrounds engage in these activities, we will expand the reach of UR and enhance our understanding of what is possible with our students. And UR will become the norm, possibly even to the point where it is required by the majority of our departments and campuses. It is possible that a Research (R) requirement for all our students will be put in place on our campuses in ways that are similar to diversity or writing requirements now.

And our next great frontier is still the curriculum, as it is fertile ground for helping students become discoverers of new knowledge. Over the past decade, the interest in a research-rich curriculum has exploded and is the number one goal that institutions who attend our workshops identify and want to embrace.

The future of UR is bright and in many respects we have won the battle, as UR is now generally accepted as a high impact

practice, and we have done a much better job in evaluating and assessing our enterprise. But there is much to do to close the deal and many skirmishes over teaching loads, resources, tenure and promotion expectations, and the purposes of research at PUI's. Let's have at it and continue to take these on.

So how do I bring this to some closure? Let me do so by showing you what the educational literature says about what matters most in college (Astin, 1993). Students are greatly influenced when they have multiple homes on campus including clubs, organizations, intramural sports, sororities, etc. I would argue that if we studied the faculty, we would find the same need, as we are all more productive, happier, and professionally alive when we find multiple homes on campus, and in the rest of our professional lives. I will conclude by saying that of all the organizations I have been involved in, CUR is the one that makes me feel most at home. It is the place where I am nurtured, I am challenged, I am supported, and where I feel the most affinities. For this I thank all of you. You are my family.

In summary, I have devoted my professional life to my students, my teaching, and my research. In doing so, I have been driven by the need to pass on to my students what was given to me nearly 40 years ago. I like to think that some day in some way, they too will pass along these gifts to another generation: the gifts of caring, teaching, mentoring, and inspiring. As a teacher, I like to think, as Newton said, we stand on the shoulders of giants.

7. Acknowledgments

So many people have impacted my professional life and have helped shape the person I have become. It started with John Williams at Rhode Island College who to this day is the finest example of what it means to be a teacher-scholar. My research advisor at the University of North Carolina, Tom Sorrell, was so much like John that it is uncanny that I ended up working for both of them. And of course, my CUR friends Mike Nelson, Jeff Osborn, Kerry Karukstis, Tim Elgren, Jill Singer, Beth Ambos, Tom Wenzel, Charlotte Otto, Nancy Hensel, and a host of others have made this such an enjoyable ride. All my love to all of you.

References

- Astin, Alexander W. 1993. *What Matters in College? Four Critical Years Revisited*. San Francisco: Jossey-Bass.
- Newman, John Henry Cardinal. 1947. *The Idea of a University*. New York: Longmans, Green, and Co.

CURQ Web Vignettes

Sustainability-related, Experiential Learning at McMaster University

Kate Whalen, Melissa Gallina, *McMaster University*, whalenk@mcmaster.ca

In 2009, the Office of Sustainability at McMaster University, in Hamilton, Ontario, Canada, established the Sustainability Internship Program with the goal of providing undergraduate students with the opportunity to address a real-world sustainability problem related to their academic studies. In doing so, students engage with academic knowledge in an applied, experiential manner. The internship program promotes engaged student learning and also fosters the engaged participation of McMaster staff and/or community members. The program was developed by the sustainability office in collaboration with a group of highly engaged students, faculty, staff, and members of the community.

Objectives of McMaster's Sustainability Internship Program

- Provide the opportunity for self-directed, interdisciplinary, and experiential learning.
- Support student learning within the university and local community.
- Engage undergraduate students in meaningful, experiential research.
- Foster opportunities for students to place local knowledge and local action within a global context.
- Provide an avenue for collaboration and information sharing among students, faculty, staff, and the broader community.
- Support career exploration.

Since the program's inception, more than 20 students across campus have successfully completed sustainability projects and received academic credit for their work. The following example of a recent internship project illustrates the effort put forth and accomplishments achieved by the interns.

In the fall of 2012, Justine DiCesare, a fourth-year science student, undertook the research and initial planning of the McMaster Outdoor Learning Space. She engaged key stakeholders through focus groups that included members of the McMaster community identified as having an academic, administrative, and/or operational interest in use of the space. Participants included undergraduates, graduate students, faculty, and staff. DiCesare obtained additional feedback from the broader McMaster campus community through an online survey. Feedback was compiled and used to propose

a design for the space, which ultimately encompassed a community-oriented vision. Through a successful grant application, this initiative received \$28,000 from the Student Life Enhancement Fund, and her recommendation for the space was submitted to and approved by McMaster's Facility Services Department, to be implemented in the summer of 2014. During her project, DiCesare worked in collaboration with faculty and students from all faculties, as well as with individuals and campus departments, from Security & Parking Services to Athletics & Recreation. (A full list of collaborators can be found in the McMaster University 2013 Sustainability Annual Report.)

How the Program Works

- First, the student intern identifies both an academic and non-academic supervisor.
- With guidance from the supervisors, the student establishes the sustainability project based on his or her personal interests. The student prepares a project plan outlining the research process and all steps for implementation, which includes the goals, objectives, and deliverables. This practice of student-led and supervisor-supported education is intended to promote sustained enthusiasm and ensure the experience satisfies the goals and expectations of the individual student.
- The academic supervisor designates disciplinary concepts, readings, and evaluation techniques that will support the student's learning as it relates to the project and also relates them to the specific course for which academic credit will be given.
- Upon successful completion of the project requirements, a grade is awarded by the supervisors and academic credit is given by the student's home faculty.

Internship Program Expanded

In the spring of 2013, the Sustainability Internship Program was expanded to provide graduate students with the opportunity for similar sustainability-related experiential learning. Melissa Gallina, a graduate student and former undergraduate sustainability intern, worked with McMaster's Office of Sustainability and various members of the community to plan and implement this expansion, now called the Graduate/Undergraduate Collaboration in Experiential Learning (GUCEL) Program. Successfully tested in the summer of 2013 as a one-year pilot program, GUCEL encourages graduate and undergraduate students to work together on an interdisciplinary project, resulting in the creation of novel intellectual communities through



Student Intern, Janelle Trant, with Engage with Waste project supporters.

the exchange of ideas, knowledge, and perspectives. The arrangement gives students the opportunity to expand their existing intellectual community to include individuals from across campus in a variety of disciplines and levels of study.

Gallina secured \$2,000 from a fund for student research and also obtained support from the School of Graduate Studies. She then drafted documents to effectively facilitate the administrative aspects of the program's operation and engaged in cross-campus consultation with each faculty's experiential education office or its equivalent.

GUCEL Program Objectives

- Enhance the student experience by contributing to an intellectual community and encouraging engaged scholarship.
- Encourage interdisciplinary and multi-level collaboration between graduate and undergraduate students.
- Foster a culture of collaboration among students, faculty, staff, and members of the broader community.

In the GUCEL Program, each student defines an individual experiential-learning project related to sustainability. Students then form interdisciplinary project groups based on their overall project goals. Through this approach, students have the opportunity to work within a team environment and contribute to the group's collective goals. Says Gallina, "Students learn how individual initiatives contribute to a larger system, and through effectively working together, they have the ability to achieve results that are greater than the sum of their parts."

An example of this approach is a project known as Engage with Waste, which undertook several separate initiatives. One initiative involved active management of McMaster's

data on the waste generated on campus. Janelle Trant, a master's student in Earth sciences, worked with the university's internal and external stakeholders to make McMaster's reports on waste more user-friendly. By including stakeholder engagement and collaboration in her project planning, she was able to identify substantial opportunities for improvements in waste-handling processes at building loading docks. Trant worked closely with managers in the Department of Facilities Services and external waste-removal companies to understand their goals, the challenges they face, and the opportunities they see.

A number of easy changes were identified. One was to redevelop the data-reporting process for McMaster used by one outside company. Along with the new reporting process, which includes an easy-to-read and interpret template for reports, a new active-management strategy was developed by McMaster's Facility Services Department. The developments made through this initiative will be used to track and measure changes in McMaster's recycling of waste, which will be reported within McMaster's 2014 report on waste. The new waste-management system will also facilitate the use of relevant data for future undergraduate and graduate research and experiential learning.

Another project focused on "e-waste," which is discarded electrical or electronic devices that may contain lead and other contaminants. Two students enrolled in McMaster's Sustainable Future Program, Aliya Satani and Carolyn Willems, facilitated an event that collected and recycled equipment during McMaster's annual Campus Sustainability Day. A total of 4,285 pounds of e-waste was diverted and generated \$340 of revenue from rebates received through the Ontario Electronic Stewardship Program. Additionally, the university saved \$260 by avoiding the costs of waste haulage and landfill fees for this material. The students engaged with students, faculty, and staff during Sustainability Day, and Twitter and Facebook pages were established to sustain communication regarding future collection events and broader collection initiatives.

Yet another project focused on employee education and engagement. Jeffrey Chan, a fourth-year life science major, is currently working with custodial staff to engage faculty, other staff members, and students in recycling of waste through improvements in infrastructure, education, and community engagement. Working closely with faculty and staff to facilitate educational presentations and incentive-based quizzes, Chan reports seeing a marked improvement in knowledge of McMaster's recycling program and processes for effective recycling. He hopes to see evidence that the

increased knowledge results in measurable improvements in McMaster's recycling of waste.

Through collaboration, information sharing, and peer support, these students were able to achieve their individual as well as group goals and objectives. The second GUCEL project, Green Jobs: Bridging the Gap, began in January and is currently under way.

The Sustainable Future Program

Initiated in January 2012, the idea of creating an interdisciplinary course on sustainability was proposed based on work being undertaken by the Task Force on Sustainability within the Faculty of Engineering. Popular support for the idea of a course led to the creation of a working group composed of stakeholders from each of the various faculties, along with members of the university administration. The goal was to develop an interdisciplinary course that would engage students in learning about sustainability through experience, research, and community involvement. The group's early discussions led to the focus on providing students with a solid understanding of sustainability from an interdisciplinary perspective, while also including experiential education, community engagement, and student-directed learning. The group realized it would take more than one standalone course to achieve this overall goal.

Throughout calendar 2012, the inaugural course, Sustain 2A03—The Sustainable Future Project, took place. A course instructor was brought onboard to develop the course content. Community outreach began with the goal of obtaining support and mentors for students' experiential-learning projects.

The primary goal of creating a standalone course on sustainability rapidly evolved into the project's becoming a program within a larger framework. The goal of this broader

Objectives for the Sustainable Future Program

- Teach students about sustainability from an interdisciplinary perspective.
- Provide the opportunity for self-directed, interdisciplinary, and experiential learning.
- Support student learning within the university and local community through:
 - Engaging undergraduate students in meaningful, experiential research.
 - Fostering opportunities for students to place local knowledge and local action within a global context.

program was to guide the direction of the inaugural course, as well as future additional courses.

The first course, Sustain 2A03, was successfully launched in January 2013 and quickly was offered for a second term. Approval to develop a second course under the Sustainable Future Program was granted. In its first offering, Sustain 2A03 engaged more than 250 people as partners and mentors who aided students' experiential learning. In all, 38 initiatives were planned, developed, and implemented by the students in the course. The second course within the Sustainable Future Program, titled Sustain 3A03—Societal Tools for Systemic Sustainable Change, was offered for the first time in September 2013.

The development of these courses was made possible through the support of many faculty—especially the Faculty of Engineering, which provided funds to administer the two courses—and staff members involved in the planning and implementation of the courses, along with members of the community who helped guide students in their experiential learning. The hard work of the students enrolled in the inaugural course, as well as the informative feedback they provided throughout, has been integral to the program's success and continued development.

For further information, see the following: McMaster Office of Sustainability, <http://asp.mcmaster.ca/>; McMaster University 2012 Sustainability Annual Report, <http://asp.mcmaster.ca/documents/Reports/Annual%20Report%202012.pdf>; McMaster GUCEL Program, <http://asp.mcmaster.ca/documents/Reports/Annual%20Report%202012.pdf>; McMaster Sustainable Future Program, <http://asp.mcmaster.ca/sfp.html>; Sustain 3A03 Course Report, <http://asp.mcmaster.ca/documents/Reports/3A03%20CR.pdf>.

Please note that the thoughts and opinions expressed within this vignette are those of the authors, and do not necessarily reflect those thoughts and opinions of McMaster University.



Sustainability Research Through the Lens of Environmental Ethics

Daniel Fouke, Sukh Sidhu, Robert Brecha, *University of Dayton*, rbrecha1@udayton.edu

Two core courses in the curriculum of the University of Dayton's Sustainability, Energy, and the Environment minor, Sustainability Research I and II, were developed out of the frustration one author, Daniel Fouke, experienced while teaching a traditional course on environmental ethics for the Department of Philosophy. The often-overwhelming nature of environmental problems tended to demoralize both the instructor and the students. Seeking a way to

integrate ethical analysis of complex problems with the search for solutions, two courses were proposed that would be team-taught by a philosopher and a scientist or an engineer. Development of the courses was initially funded through a course-development fellowship from the college of Arts and Sciences.

The rationale for these courses is the recognition that technical and scientific knowledge cannot, by itself, provide reasons for utilizing that knowledge for ethical purposes. Similarly, ethical reasoning cannot operate in a vacuum. That is, individuals cannot have a duty to do what it is impossible to achieve. The courses facilitate understanding of how science, technology, and ethical analysis have a symbiotic relationship in assessing solutions to environmental problems—knowing our duties toward the natural world requires understanding what science tells us about the nature of environmental problems and then evaluating the strengths and limitations of technological solutions.

In Sustainability Research I, projects focus on institutional sustainability using the University of Dayton as a case study. Sustainability Research II is structured around projects developed in cooperation with community partners off campus. Research projects in both courses vary by semester according to what students choose to pursue, but topics include renewable energy, energy efficiency, purchasing policies that promote sustainability, effective means of promoting recycling, the benefits of sustainable landscaping, and the value of increasing biodiversity in institutional landscapes.

In the second course, students come to understand and articulate how local practices are affected by economic, moral, and aesthetic values, as well as political structures, and they learn that all local environmental problems have global consequences. Students come to appreciate the necessity of integrating knowledge across disciplines in order to engage in practical, ethical action on a local level, and they learn to analyze the practices and policies of a campus, city, or neighborhood while conducting their research. They present ethical, aesthetic, and economic analyses and arguments for implementing particular sustainable alternatives. Along the way, students learn how to work with institutional actors such as local officials and community organizations to achieve change, and how to persuasively present research findings to these individuals or organizations by combining moral and economic arguments with technical information.

On a practical level, in both classes sessions alternate between teamwork on projects, during which the instructors advise students on their projects and help them to deal with any problems they are confronting, and class-discussion

days, when students prepare summaries of the assigned readings or participate prior to class in online discussions. The readings for the courses are tailored to the problems the research projects are designed to solve, along with more general readings on sustainability, the social and natural sciences, and environmental ethics. Additional assessment comes through a paper individual students write on ethics, sustainability, and educational or civic institutions. Project results are presented at a public forum on campus and delivered as a final product to relevant officials in the university administration or to community partners. Individual students are also required to submit evaluations of their own work and that of the other members of their research team, and at the end of the semester, to write letters of reflection for next year's class, perhaps the most powerful form of assessment. Following are a few excerpts from those letters.

From an engineering student (male): "Welcome to one of best educational experiences you will come across while at the University of Dayton. The class you are about to take is not a typical research class, or ethics class for that matter. This class gives you the opportunity to connect with your fellow classmates differently than any other group project or assignment. Depending on how much effort your group puts into the class, the end results can be something that can be recognized campus or city-wide!"

From a business major (female): "Initially, I chose to take this course as part of my minor, Sustainability, Energy, and the Environment. ... Before taking this class I knew little to nothing about the importance of trees and the free ecosystem services they provide, the role of universities in land conservation, how ecosystems work as communities and how a single disturbance can throw them off entirely, how sustainable land management can cut costs and save labor hours, the importance of native plants and animals, and the risks of invasive species, among other things. In addition to all of these things, I learned about our moral obligation as humans to take care of the environment, not only because it is valuable to us but because it has value in itself. This part of the course was very different and really opened my eyes to a whole new way of seeing the environment. ... When I walked into the classroom on the first day ... I was immediately intimidated. ... My professors were a Philosopher and an Engineer; I have never loved Philosophy and I know nothing of Engineering. ... For all I knew, these people thought I was dumb; isn't that what Engineers think of Business majors? Needless to say, I was wrong. I ended up having the same amount of prerequisite knowledge to be a useful part of the class as everyone else and I fit in just fine."

Finally, from a second engineering major (female): “This ... course is totally unlike any you have ever taken before. The professors act more as guides rather than traditional professors. You can converse about any topic, but they leave most of the learning and teaching up to you individually. In this class you will explore ideas that you have never even considered, diving deep into moral and ethical obligations in relation to the environment. These discussions can be challenging and you may not see where others are coming from, but if you keep an open mind and stay true to your opinions, it will allow for a more fruitful discussion. ... This semester I truly took a responsibility for what I learned in class ... (working) on a project that analyzed water usage at the University of Dayton, from past to present and created solutions for the future. I truly took responsibility and felt possessive of the subject I studied and found out so many things about myself and the University of Dayton that I had never known.”

Although there are challenges to teaching a course of this type, ranging from institutional hurdles in organizing team-teaching in an equitable fashion, to the legwork necessary for coordinating and developing potential projects with university divisions and community partners, the clear benefits that arise from allowing students to follow their passion and take charge of the learning process are clear rewards for the initial effort. 

Creating Value Through Prizes for Undergraduate Research in Sustainability

Lynette Overby, *University of Delaware*, Roger Strong, Jr., *Gale-Cengage Learning, Inc.*, Mark Christel, *The College of Wooster*, Gretchen Sneff, *Gregory McKinney, Temple University* Rebecca Maniates, *Yale-NUS College*, *roger.strong@cengage.com*

Gale-Cengage Learning, a leading e-research and educational publisher, has established a successful prize program recognizing undergraduate interdisciplinary research into sustainability issues, in collaboration with several universities. The research awards offered by this program support institutional faculty and student needs in teaching and learning, particularly regarding the growing need to recognize interdisciplinary research. Collaborations involve Temple University, the University of Delaware, the College of Wooster, and, most recently, Pennsylvania State University.

Temple University

Gale-Cengage Learning approached Temple University Libraries in 2010 with a proposal to fund a prize to be awarded by the libraries for undergraduate research on sustainability and the environment. With another well-established library prize already in place, Gale's offer represented a new

opportunity for the libraries to expand their recognition of outstanding undergraduate research that encourages the development of students' competencies in information literacy. The libraries accepted the offer and a reception each spring features presentations by student winners and their faculty mentors. It is a celebration of the partnership among librarians, university administration, faculty, and students in students' learning.

The traditional Library Prize for Undergraduate Research receives entries primarily from students in the humanities and social sciences. Partnering with Gale on the added Library Prize on Sustainability and the Environment has enabled the libraries to reach out to students in science, engineering, and other areas in which students study sustainability and the environment. The libraries have welcomed this opportunity to support and highlight student research excellence.

In addition to supporting student-learning goals, the Library Prize on Sustainability and the Environment enables librarians to demonstrate campus leadership on these important issues and creates an opportunity for librarians to work with Temple's Office of Sustainability. The director of that office serves on the panel judging entries in the award competition each year, along with faculty members and librarians, and thus sees a full range of student research on these topics. The prize also supports the university's goals as part of the American College and University President's Climate Commitment to accelerate educational efforts about climate change.

University of Delaware

The Sustainability Prize was established by the University of Delaware's Undergraduate Research Program and Gale to encourage undergraduate research and projects in the area of sustainability. The sustainability prize is an integral component of the Summer Scholars Programs at the university. More than 300 students are eligible to apply for the award, and they may be from any discipline. Their projects may encompass research and/or service. This prize is awarded in conjunction with Gale providing access to GREENR for University of Delaware students and faculty. This database supports sustainability research and reference topics on the environment, energy, and natural resources.

Established in academic year 2010-2011, four projects were selected to receive awards. Student Matthew Fischer was the first-place prize winner for a paper entitled Kinetics of Arsenite Oxidation by Manganese Oxide Minerals: Importance for Water Quality and Environmental Sustainability. In 2012, four prizes were given and the first-place winner was Taylor Smith for a project titled Biochemical Processes Utilizing Electrogenic Bacteria. The 2013 first-place awardee was

public-policy major Nicole Seymour for her project titled *The Car-Free Guide: An Outcome of the Assessment of Transit-Friendliness in the City of Newark, Delaware*.

The application students submit requires them to:

1. Write and submit as part of your application a 500-word abstract, with the following sections, a. motivation/problem statement, b. methods/procedure/approach, c. results/findings/products, and d. conclusions/implications/potential benefits of your research/project to environmental sustainability.
2. Include a brief statement (150-200 words) about the impact of this research/project on your personal and career goals.
3. Include a resume.

After the applications are received, they are evaluated by three faculty reviewers according to the rubric in Figure 1.

The award is presented at the conclusion of the 10-week Summer Scholars Programs, at the university's annual Undergraduate Research and Service Celebratory Symposium.

College of Wooster

The College of Wooster is the most recent institution to become involved in Gale's initiative for research awards. Mentored undergraduate research is a hallmark of a Wooster education and since 1947, every graduate has participated in the college's distinctive Independent Study (I.S.) Program (<http://www.wooster.edu/research>), which pairs every senior with a faculty mentor for a yearlong research project. As Wooster officials considered how the Gale-Cengage awards might best work at the institution, it seemed natural to design a scholarship program that honored the most outstanding I.S. projects on sustainability.

The college's I.S. Research Prize in Sustainability and the Environment recognizes projects that contribute to understanding of sustainability and the environment, but it also considers "originality, depth, breadth, or sophistication in the use of information resources, as well as exceptional ability to select, evaluate, synthesize, and utilize information resources in the creation of a project in any media." During each year of the program, first-place, second-place, and honorable-mention awards are given for the top three projects. The winners of the first round of awards were selected in spring 2013, and the three recipients were featured on a panel during Wooster's Research Symposium (<http://www.wooster.edu/research/symposium>), an annual event at which seniors share their research through presentations, digital

Figure 1. Evaluation Criteria for the University of Delaware's Interdisciplinary Undergraduate Research in Sustainability Prize

Criteria	Beginning (1 point)	Competent (2 Points)	Excellent (3 points)
Thesis	Develops a relevant thesis.	Develops a manageable scope and focus; poses an interesting question or problem.	Modifies thesis to incorporate initial findings and surprising insights.
Synthesis	Connects several ideas from a few sources to the thesis.	Draws on multiple ideas from several sources to form conclusions.	Synthesizes ideas from many sources to reach original conclusions or novel insights.
Originality	Interesting topic but not very original.	A highly imaginative topic or approach	A new twist on previous research; an original contribution to the field.
Topic	Interesting topic related to sustainability and the environment.	Highly imaginative ideas about an aspect of sustainability and the environment, or sustainable practices.	Creates important new knowledge about sustainability and the environment, or proposes/improves upon practices that may have a significant impact.
Initiative	Closely guided by faculty at all stages of research.	Fairly independent throughout, though seeking advice when necessary.	Highly independent throughout, though seeking advice when necessary.
Faculty letter of support	Faculty mentor indicates that the students' work has the potential to be successful, but is in the beginning stages.	Faculty mentor indicates that the students' work is somewhat successful, innovative, and important.	Faculty mentor indicates that the students' research/project is highly successful, innovative, and important.
Relationship to future goals	Research/project has very little relationship to the student's future goals.	Research/project is somewhat related to the student's future goals.	Research/project is directly related to the student's future goals.

projects, and poster sessions. The three presenters discussed their individual projects and also the unique ways each student approached the research process. The session was a very effective means of highlighting undergraduate research on sustainability, and we anticipate future recipients will participate in similar panel presentations each year.

Conclusion

The libraries at Temple University, the College of Wooster and the University of Delaware, as well as the undergraduate research program at the University of Delaware, have found working with Gale to be a rewarding partnership. The librarians and undergraduate research programs have developed a new prize to enhance outreach and promote all relevant library resources. Gale has benefitted from opportunities to collect feedback from faculty, students, and librarians on resources to support teaching and learning in these areas. Notably, Gale has provided the opportunity for winning entries to be peer-reviewed and included in the GREENR database, helping talented students develop resumes and a research experience that may enhance their academic careers. 

Caring for a Shared Place: Undergraduate Research to Restore an Urban Watershed

Gail Gunst Heffner, David P. Warners, *Calvin College*, gheffner@calvin.edu

Much has been written about service-learning as a pedagogy that strengthens undergraduate education. In the late 1990s Calvin College, like many other institutions across the country, experienced considerable growth in academically based service-learning. In 1997, the Calvin Environmental Assessment Program (CEAP) emerged as an effort to integrate service-learning into the natural science curriculum. CEAP has involved faculty members in creating regular lab assignments or course projects to collect data that contribute to an overall assessment of the environment of the campus and surrounding community. The program also has been integral in creating institutional practices that foster sustainability and providing a context for meaningful links between the college and the broader community. From this work we discovered that the creek draining the watershed in which our college exists is highly degraded. The realization of our institutional and collective personal complicity in its degradation led us to organize an initiative for restoration of the watershed that has become known as Plaster Creek Stewards.

Plaster Creek Stewards is a collaboration of Calvin College faculty, staff, and students, working with local schools, churches, and community partners to foster sustainability and restore the health of the watershed. The initiative focuses

on three areas: research, education, and on-the-ground restoration. Education and outreach are needed to increase awareness of the problems; on-the-ground restoration addresses the degradation this stream has experienced; and research is needed to help us learn more about the creek and how to best work toward its restoration.

Involving undergraduates in this research has been an important development. Students are eager to invest themselves in research that has real-world implications, especially when the “real world” is the very watershed in which their college exists. We currently advise four active research programs connected to the watershed:

1. A research-methods class (Biology 250) is the fourth semester of our core biology sequence. The Plaster Creek Watershed serves as the laboratory for this class; students perform experiments and write research reports that inform our restoration activities.
2. Faculty in the natural sciences have mentored a number of summer research students on projects related to water quality, bird diversity and behavior, bacterial dynamics, Geographic Information Systems modeling, and restoration of native habitat.
3. Senior engineering students have been involved in yearlong projects addressing stormwater runoff, de-channelization, and bio-swale design for large-scale stormwater retention.
4. A Calvin faculty member in the social sciences has directed students in an oral history project documenting the life experiences of long-time residents of the watershed. A history professor has directed students in documenting past urban and rural land-use practices and their impacts across the watershed.

By promoting sustainability on a watershed-wide scale, we have created opportunities to engage students in authentic interdisciplinary, place-based research. In addition, faculty members from a wide array of disciplines (history, English, biology, environmental science, engineering, urban studies, geography, education) are increasingly drawn to this watershed restoration initiative for their scholarly activity. This work has garnered more than \$1.5 million in grants for ongoing research and on-the-ground restoration activities, and it continues to inspire our campus and our local community to live more sustainably in the Plaster Creek Watershed. 

UNDERGRADUATE RESEARCH Highlights

Wise, CF, Wise, JTF, Wise, SS, Thompson, WD, Wise Jr., JP, Wise Sr., JP. Chemical Dispersants Used in the Gulf of Mexico Oil Crisis are Cytotoxic and Genotoxic to Sperm Whale Skin Cells. *Aquatic Toxicology*. 2014; 152: 335-340. (University of Southern Maine)

In 2010, the Deepwater Horizon Rig exploded, releasing millions of gallons of crude oil into the Gulf of Mexico. Unprecedented amounts of chemical dispersants were used in the clean-up attempt. This research examines the effects of the dispersants on the skin cells of sperm whales. John P. Wise is a professor of toxicology and molecular epidemiology in the Department of Applied Medical Sciences at the University of Southern Maine and the director of the Maine Center for Toxicology and Environmental Health. Catherine Wise is starting a doctoral program in toxicology at North Carolina State University this fall. This work was supported by the Prince William Sound Regional Citizens Advisory Council and the Maine Center for Toxicology and Environmental Health [955.12.02]. This paper was developed under a GRO Fellowship Assistance Agreement, number MA-91739301-0, awarded by the U.S. Environmental Protection Agency (EPA). It has not been formally reviewed by the EPA. The views expressed in this paper are solely those of the authors, and the EPA does not endorse any products or commercial services mentioned in this paper.

Aldeborgh H, George K, Howe M, Lowman H, Moustakas H, Strunsky N, Tanski JM. Analysis of Small Molecule X-ray Crystal Structures: Chemical Crystallography with Undergraduate Students in a Teaching Laboratory. *Journal of Chemical Crystallography*. 2014; 44: 70-81. (Vassar College)

This report describes the spectroscopic characterization and X-ray crystal structures of six small molecule organic compounds obtained by undergraduate students enrolled in an advanced integrated laboratory course at Vassar College in 2012. The structures reveal several different types of intermolecular interactions, such as hydrogen bonding, pi-stacking, halogen-halogen interactions, and C-H...X (X = O, N, halogen) interactions. Intermolecular interactions are important for students to learn about as they come to understand the ways in which atoms and molecules may pack together in the solid state. A high-impact way to teach students about different types of intermolecular interactions, while integrating teaching and research, is requiring them to determine an X-ray crystal structure and engage in the writing process to publish the results. Tanski is a professor of chemistry at Vassar College. Aldeborgh is a laboratory

manager at Memorial Sloan-Kettering Cancer Center. George is a 2014 graduate of Vassar College with a major in drama and a minor in chemistry. Howe is a 2014 graduate who will attend graduate school in chemistry at UCLA. Lowman is employed at a legal consulting firm and specializes in renewables and the environment. Moustakas is a 2014 graduate who will attend graduate school in chemistry at Dartmouth College. Strunsky is attending graduate school in counseling at Westminster Theological Seminary. The work was supported by Vassar College and the National Science Foundation under Grant No. 0521237 to Tanski.

Babinkostova L, Bombardier KW, Cole MC, Morrell TA and Scott CB. Algebraic Properties of Generalized Rijndael-like Ciphers. *Groups Complexity Cryptology*. 2014; 6: 1: 37-54 (Boise State University)

AES (Advanced Encryption Standard) is a block cipher chosen in 2001 as the United States' official symmetric key cryptosystem for top secret information. Although all current attacks on AES are too slow to be practical attacks, there are theoretical attacks that raise concern about the long-term security of AES. A motivation for investigating the group theoretic structure of AES and alternative platforms and specifications is to identify and exclude properties that can be exploited to undermine the security of such systems. In this paper we examine such conditions for AES-like systems over several mathematical platforms. Babinkostova is an associate professor of mathematics and the director of the Complexity Across Disciplines Program, supported by a National Science Foundation REU grant, at Boise State University. Morell is currently enrolled in a doctoral program in mathematics at the University of Wisconsin. Bombardier is currently enrolled in a doctoral program in mathematics at the University of Iowa. Cole is currently enrolled in a doctoral program in mathematics at Brown University. Scott is currently working at Colorado College. The research was supported by the National Science Foundation (DSM 1062857) and Boise State University; the grants were awarded to Babinkostova.

Macedo NJ, Neto CC, Liberty AM, Ferreira TL. Zebrafish as an in Vivo Screen for Early Black Cranberry Proanthocyanidin Biomolecular Activity. *American Journal of Molecular Biology*. 2014; 4: 2: 37-48. (University of Massachusetts Dartmouth)

The present study was designed to test in vivo the role of cranberry proanthocyanidins (PACs) in inhibiting cancer-cell survival. The zebrafish are a useful in vivo model,

and they were used to look at the effect of PACs on developing embryos. In vitro results were supported showing that the PACs inhibit cells undergoing rapid cell division preferentially over adult normal cells. This work supports in vitro work indicating that PACs can inhibit cancer cells more than normal cells. Tracie Ferreira is an associate professor in the Department of Bioengineering. Cathy Neto is a professor in the Department of Chemistry/Biochemistry. Nicholas Macedo began this work as a sophomore in the bioengineering program and performed this work as a summer project and throughout the following semester as an independent project. He was supported by an incentive grant for undergraduate research from the dean's office of the College of Engineering, as well as funds from the Office of Undergraduate Research at UMass Dartmouth.

Chen L, Drake MR, Resch MG, Greene ER, Himmel ME, Chaffey PK, Beckham GT, Tan Z. Specificity of O-glycosylation in Enhancing the Stability and Cellulose Binding Affinity of Family 1 Carbohydrate-binding Modules. *Proceedings of the National Academy of Sciences of the United States of America*. 2014; 111. (University of Colorado at Boulder)

The study examined the functional role of O-glycosylation in the industrially relevant Family 1 carbohydrate-binding module (CBM). A library of 20 different glycosylation variants of the CBM were synthesized and characterized for their binding affinity to native cellulose, thermal stability, and proteolytic stability. It was found that proteolytic stability was dependent on glycan density, and that thermal stability and binding affinity enhancement were glycan site- and pattern-specific. Tan is an assistant professor at the University of Colorado at Boulder in the Chemistry and Biochemistry Department and BioFrontiers Institute. Greene performed the research during his junior and senior year as part of an independent study project. He will be pursuing a PhD in molecular and cell biology at the University of California, Berkeley beginning in fall 2014. The research was supported by a Department of Chemistry and Biochemistry Start-up Grant and a mini-grant from the Undergraduate Research Opportunities Program awarded to Greene.

Lee, H-c, Le Grice, V, Blakeslee, JP, Jensen, JB, Lee, Y. Stellar Populations of 16 Galaxies from the Hubble Space Telescope WFC3/IR Surface Brightness Fluctuation Observations. *Bulletin of American Astronomical Society*. 2014; 223. <http://adsabs.harvard.edu/abs/2014AAS...22315201L>. (The University of Texas-Pan American)

We have estimated the luminosity-weighted ages of 16 early-type galaxies in Virgo and Fornax clusters based upon the near-IR (F110W and F160W) SBF observations using

the Hubble Space Telescope (HST). Hyun-chul Lee is an astronomy lecturer. Victoria Le Grice, an English major, successfully finished her minor in astronomy and will start graduate study at Texas State University. The research was supported by NASA through a grant from the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy, Incorporated, under NASA contract NASS-26555. Partial support also came from the Undergraduate Research Initiative at the UTPA.

June CM, Vallier BC, Bonomo RA, Leonard DA, Powers RA. Structural Origins of Oxacillinase Specificity in Class D beta-lactamases. *Antimicrobial Agents and Chemotherapy*. 2014; 58: 1: 333-341. (Grand Valley State University)

The structural basis for differences in substrate selectivity between two class D beta-lactamases was examined by determining the X-ray crystal structures of the enzymes in complex with the beta-lactam substrate oxacillin. Comparison of the complexes provides novel insight on how substrate selectivity is achieved among subtypes of class D beta-lactamases. By elucidating important active site interactions, these findings can also inform the design of novel antibiotics and inhibitors. Powers is an associate professor of chemistry. Vallier is currently employed at Perrigo, Inc., as a quality-control technician. She conducted the research presented in this paper over the summer and academic year 2011-2012. This research was supported by an NIH R15 AREA grant to Powers.

Murph JH, Faulkes Z. Abundance and Size of Sand Crabs, *Lepidopa benedicti* (Decapoda: Albuneidae), in South Texas. *The Southwestern Naturalist*. 2013; 58: 4: 431-434. (The University of Texas-Pan American)

Sand crabs are a widely spread but little known family of crabs. This was the first research project to study the ecology of any species in this family. Faulkes is an associate professor in the Department of Biology. Murph performed this research as part of an REU program at UTPA in 2009-2010 and was supported by a National Science Foundation Research Experience for Undergraduates Site grant (award DBI- 0649273). She is currently a graduate student at Capella University.

Flinchum BA, Louie JN, Smith KD, Savran WH, Pullammanappallil SK, Pancha A. Validating Nevada ShakeZoning Predictions of Las Vegas Basin Response Against 1992 Little Skull Mtn. Earthquake Records. *Bulletin of the Seismological Society of America*. 2014; 104:1: 439-450. (University of Nevada, Reno)

This study developed a method of computing ground motions from earthquakes in Nevada and validated computations for

Las Vegas against recordings of southern Nevada's largest natural earthquake. Louie is a professor of geophysics in the Nevada Seismological Laboratory who teaches in the Department of Geological Sciences and Engineering of the Mackay School of Earth Sciences and Engineering, College of Science. Louie employed Flinchum and Savran as undergraduate interns from 2011 to 2012. Flinchum is currently enrolled in a master's program in geophysics at the University of Wyoming. Savran is currently in a joint San Diego State University-Scripps Institution of Oceanography PhD program. The research was supported by federal grants, UNR Foundation funds, and lab funds. Savran won a related undergraduate-research award from the university and a summer fellowship from the Southern California Earthquake Center. Flinchum undertook a summer internship from the Incorporated Research Institutions for Seismology at Miami University of Ohio.

Moreno D, Zunino F, Paul A, Lopez M. High strength Lightweight Concrete (HSLC): Challenges When Moving from the Laboratory to the Field. *Construction and Building Materials*. 2014; 56: 44-52. (Pontificia Universidad Católica de Chile)

High strength lightweight concrete (HSLC) has been studied extensively in the laboratory and used in projects over the last decade. Few studies have focused on the issues associated with the field implementation of HSLC, and these issues are explored and addressed in this study. There are small differences in the compressive strength, unit weight, modulus of elasticity, tensile strength, and bond strength of HSLC between the laboratory and the field. Special considerations during mixture design, careful moisture control of the lightweight aggregates, and consolidation are crucial for minimizing variability and maintaining performance in the field. Lopez is an associate professor in the School of Engineering at the Pontificia Universidad Católica de Chile. Moreno developed this research as part of his thesis work for a master's of science at the university. Zunino is currently a graduate student in the master's program at the institution. He collaborated on the data analysis and writing of this research paper as undergraduate in civil engineering through an undergraduate-research opportunity offered by professor Lopez. Paul is currently a PhD student at the Georgia Institute of Technology and collaborated on this research after completing his studies for a master's of science at the Chilean university. The research was funded by INNOVA-CORFO (07CT7PCT-09).

Frank MG, Hershman SA, Weber MD, Watkins LR, Maier SF. Chronic Exposure to Exogenous Glucocorticoids Primes Microglia to Pro-inflammatory Stimuli and Induces NLRP3

mRNA in the Hippocampus. *Psychoneuroendocrinology*. 2014; 40: 191-200. (University of Colorado)

Chronic stress, as well as chronic treatment with glucocorticoids (GCs), primes the neuroinflammatory response to a subsequent pro-inflammatory challenge. However, it remains unclear whether chronic GCs sensitize the response of key CNS immune substrates (i.e., microglia) to pro-inflammatory stimuli. In the study, chronic exposure to GCs induced a primed immunophenotype in microglia and sensitized microglia to pro-inflammatory stimuli. This work adds to a growing body of evidence suggesting that a permissive function of GCs is that of an endogenous danger signal. Frank is a senior research associate in the laboratory of Maier and Watkins in the Department of Psychology and Neuroscience. Hershman graduated from the University of Colorado Boulder in 2014 with a bachelor's degree in integrative physiology. She worked on this project as an undergraduate research assistant from 2012 to 2014, and she is currently applying to medical school while employed as a research assistant. The research was supported by fellowship awards to Hershman from the Undergraduate Research Opportunity Program and Biological Sciences Initiative at the University of Colorado Boulder in partnership with Howard Hughes Medical Institute.

Krall EM, Klein TW, Andersen RJ, Nett AJ, Glasgow RW, Reader DS, Dauphinais BC, Mc Ilrath SP, Fischer AA, Carney MJ, Hudson DJ and Robertson NJ. Controlled Hydrogenative Depolymerization of Polyesters and Polycarbonates Catalyzed by Ruthenium(II) PNN Pincer Complexes. *Chemical Communications*. 2014; 50: 4884-4887. (Northland College and University of Wisconsin-Eau Claire)

Billions of pounds of plastics are discarded each year, often after a single use. This study led to a new process for harvesting valuable chemicals from used plastics. Ruthenium(II) PNN catalysts hydrogenate polyesters to diols and polycarbonates to glycols plus methanol. Many of these dialcohols and glycols, which are currently derived from petroleum, are used in large amounts by chemical producers. Nicholas Robertson is an assistant professor of chemistry at Northland College, and Michael Carney is a professor of chemistry at University of Wisconsin-Eau Claire. Ten undergraduate students performed all of the laboratory work for this project over two years (2012-2013): seven at Northland College (Eric Krall, Tyler Klein, Ryan Andersen, Diana Reader, Brian Dauphinais, Sean McIlrath and Dylan Hudson) and three at UW-Eau Claire (Alex Nett, Ryley Glasgow and Anne Fischer). Krall is pursuing graduate school in coatings and polymeric materials at North Dakota State University. Andersen is employed and considering graduate school. Reader is pursuing graduate work in physical therapy.

McIlrath is enrolled in a doctoral program in chemistry at Northern Illinois University. Klein and Hudson are chemistry majors at Northland College in their junior years and are continuing on this project. Nett and Fisher are enrolled in PhD chemistry programs at the University of Michigan and Marquette University, respectively. Glasgow is a junior with a double major in chemistry and computer science at UW-Eau Claire. This work was supported by a Cottrell College Science Award from the Research Corporation for Science Advancement to NJR, and by the UW-Eau Claire Office of Research and Sponsored Programs.

Vaughan MB, Odejimi TD, Morris TL, Sawalha D, Spencer CL. A New Bioassay Identifies Proliferation Ratios of Fibroblasts and Myofibroblasts. *Cell Biology International*. 2014; 38 : 981-986. (University of Central Oklahoma)

This study tested a new method to visualize proliferation and differentiation of myofibroblasts; the assay allows the user to identify four different cell types within a population of cells. Treatments that target one of these cell types may now be monitored using this staining assay. Vaughan is a professor of biology; Morris is an associate professor of mathematics and statistics. Both Odejimi and Spencer were sophomores with student RCSA grants when they began this project and received additional support to continue work as juniors. Sawalha was a master's student in biology. Odejimi will enter Creighton Dental School next semester; Spencer is currently a senior in biomedical engineering. The research was supported by a UCO faculty RCSA grant to Vaughan, student RCSA grants to Odejimi and Spencer, a McNair Scholar award to Odejimi, and an NSF-OK-LSAMP grant to Spencer.