

CUR Fellow's Address

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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 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/doctrinary/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>.

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