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ARTICLE *in* JOURNAL OF CHEMICAL EDUCATION · AUGUST 2009

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Transformative Research Initiative: The Role of Undergraduate Institutions

by Kerry K. Karukstis

Transformative Research: Responding to the Renewed NSF Commitment

The Council on Undergraduate Research (CUR) recently received funding from the National Science Foundation (NSF), the Research Corporation for Science Advancement (RCSA), and the ACS Petroleum Research Fund to support a summit involving leading scientists at predominantly undergraduate institutions (PUIs) to address the role of those institutions in potentially transformative research. The summit was prompted in part by the renewed commitment of the NSF to support transformational and paradigm-challenging research as articulated in the National Science Board report, "Enhancing Support of Transformative Research at the National Science Foundation" (1). In particular, transformative research is articulated as a core NSF value and the descriptor "potentially transformative" is now included as an element of the intellectual merit criterion for NSF proposal review. Thus it is critical for the undergraduate research community to consider viable mechanisms to foster the type of critical and innovative thinking that is required for scientific research to be truly transformative. The summit meeting held in June 2009 was the first step in that process.

Summit Meeting Preparations

A summit planning committee was formed by CUR President Jeff Osborn that included Tom Wenzel (Bates College), Paula Dehn (Kentucky Wesleyan College), Beth Cunningham (Illinois Wesleyan University), Nancy Hensel (CUR Executive Officer), and committee chair Kerry Karukstis (Harvey Mudd College). The planning committee invited 20 additional participants representing a range of disciplines in science, engineering, and mathematics who are recognized for their involvement in and support of high-quality collaborative research with undergraduates at predominately undergraduate institutions.

To prepare for the summit discussions, three significant readings on transformative research were suggested to the participants. These recommendations included:

1. A speech by Arden L. Bement, Jr., NSF Director, "Transformative Research: The Artistry and Alchemy of the 21st Century" (2). In this speech, Bement notes: "We [the NSF] use this term [transformative research] to describe a range of endeavors, which promise extraordinary outcomes; such as, revolutionizing entire disciplines, creating entirely new fields, or disrupting accepted theories and perspectives. In other words, these endeavors have the potential to change the way we address challenges in science and engineering and also provide grist for the innovation mill. Supporting transformative research is of critical importance in the fast-paced, science and technology-intensive world of the 21st century."
2. The National Science Board's 2007 report, "Enhancing Support of Transformative Research at the National Science Foundation" (1). In December 2004 the National Science Board (NSB) established the Task Force on Transformative Research to gain a better understanding of NSF policies to solicit, identify, and fund innovative, potentially transformative research. This report contains the NSB's findings and recommendations for NSF to enhance its ability to identify and fund transformative research.
3. The results of a 2007 NSF Proposer Survey (3). A working group of the NSF was established in March 2006 to perform a detailed study of the trends, impacts, and causal factors associated with recent declines in NSF proposal funding rates and the simultaneous growth in NSF proposal submission rates. The survey focused on the proposal submission process, factors that influence decisions to submit research proposals, and perceptions of funding rates within NSF and other organizations. A number of the questions pertained to transformative research, including perceptions of the extent of NSF proposals that constitute transformative research, perceptions of whether reviewers and review panels welcome proposals involving transformative research, the extent to which proposal authors submit NSF proposals concerned with transformative research, and the particular agencies to which proposal authors submit transformative research proposals.

Details of the Summit Meeting

The meeting included presentations on key questions to initiate the conversation, but the emphasis was on a facilitator-guided discussion involving all participants. Arthur B. Ellis, Vice Chancellor for Research at the University of California, San Diego, served as the summit facilitator. During his tenure as Director of the Division of Chemistry at NSF, Ellis was a participant in the NSB workshops that led to their report on transformative research efforts at the NSF (1). In addition to being deeply conversant on the issues of transformative research, Ellis is a strong supporter of undergraduate research and thus an ideal facilitator for this summit.

The summit was organized around three plenary sessions. The first plenary was given by Tom Wenzel (Bates College) and addressed the question: Why Should Undergraduates and Primarily Undergraduate Institutions (PUIs) Be Involved in Transformative Research? He reiterated the CUR belief that undergraduates benefit by participating in original research, particularly high-quality research characterized by its original intellectual or creative contribution to the discipline. The best of such research would be potentially transformative, and all constituents—the institution, the faculty, the students, and society—would benefit from such investigations. Wenzel felt that the more difficult issue was the extent to which it is

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possible to conduct transformative research at PUIs, citing the possible lack of infrastructure, often high teaching loads, and the likely inexperience of undergraduate collaborators. Nevertheless, faculty members at PUIs may have the ability to take on a high-risk, high-gain idea when not held to substantial productivity expectations (e.g., grants and publications). Wenzel noted three key factors that likely contribute to a person's ability to conduct transformative research, including the ability to identify transformative problems or questions and to then generate transformative ideas for solving them; the ability to recognize serendipitous discoveries; and the ability to form collaborations among faculty peers, particularly emphasizing interdisciplinary interactions.

James Gentile, President of Research Corporation for Science Advancement, and Art Ellis shared the second plenary focused on: How is transformative research defined? Why should funding agencies support transformative research? What is the status of transformative research in the U.S.? Gentile highlighted the ways in which RCSA seeks to play a catalytic role in scientific research, rapidly responding to new opportunities and challenges. He reminded participants that transformative research is all about the ideas and the research environment, not the category or type of institution that pursues the research. He noted that science is advanced by both positive and negative outcomes and that, while new ideas are crucial, transformative research can also involve recycling as it applies "traditional/old" ideas in an unexpected setting. He did urge those present not to underestimate the power of incremental research. His final recommendations to summit attendees were: take risks, embrace and grow from failure, build on tradition, and think in different ways with unique partnerships. Ellis reviewed the impetus for the 2007 National Science Board report and provided the audience with a framework for thinking about how a federal funding agency makes investments in research, looking at the integrated impact of the research as a function of the integrated resources applied to the investigations (time, funding, etc.). He urged PUIs to make the connection of use-inspired research to student education, stressing the importance of integration of the institutional education mission with its research mission. He articulated two particular challenges that PUIs will face in conducting potentially transformative research: acquiring nontraditional sources of funding and rethinking the metrics used to assess the success of research beyond standard counts of publications and grants.

The final plenary involved a panel of presenters including Julio J. Ramirez (Davidson College); Paula F. Dehn (Kentucky Wesleyan College); and Sean Decatur (Oberlin College). These panelists offered their views on the question: How do we promote transformative research at PUIs? The speakers outlined their views on current obstacles and disincentives for undertaking high-risk research at PUIs and offered recommendations to change institutional culture to foster transformative thinking, promote collaborations and interdisciplinary connections, and reward those undertaking more challenging projects with less certain outcomes.

Following group discussions after each plenary, participants outlined key topics to address in breakout sessions. The final breakout session of the summit involved the development of action plans to address the challenge: What are the next steps that NSF, CUR, and PUIs can take to support potentially transformative research at PUIs? Many significant recommendations were made and prioritized.

Dissemination of Summit Recommendations

One of the goals of the summit was to generate a monograph that will highlight the issues addressed during the gathering and outline the recommendations emanating from the discussion.

The monograph is currently in preparation and will be made available on CUR's Web site (4) and in a printed version. In order to broaden the discussion about transformative research at predominantly undergraduate institutions, CUR will present workshops at a variety of professional meetings as well as host a Web conference to more directly involve CUR members and the undergraduate research community in the discussion. Specific information about these upcoming events stemming from the Transformational Research Summit will appear on the CUR Web site (4). CUR looks forward to these and other venues to share recommendations to assist PUIs and undergraduate students in engaging in scientific research that can contribute to potentially transformative discoveries.

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Kerry K. Karukstis is Past-President of CUR and is a member of the Department of Chemistry, Harvey Mudd College, Claremont, CA 91711; Kerry_Karukstis@hmc.edu.