

NSF Workshop on Undergraduate Research Centers

Despite a track record of outstanding technical achievements in chemistry and related fields, there is growing concern that the number of U.S. students electing this career path is steadily declining. As shown by data taken from the National Science Foundation's Science & Engineering Indicators 2002, the total number of degrees awarded in the physical sciences has decreased almost 13% since 1980. To sustain and diversify our outstanding technical work force in these fields will require significant creativity and investment in educational infrastructure so that more students, particularly freshmen and sophomores, will be encouraged to select chemistry as a major. This goal requires that we deepen the pool of students we attempt to reach by involving them at an earlier stage of their academic careers, and that we expand the pool by including students at institutions with limited resources, such as community colleges and rural institutions.

Participation in research activities is now widely recognized as a key determinant in encouraging students to pursue careers in the sciences. Research is also known to be a powerful pedagogical tool that significantly enhances the quality of undergraduate science education insofar as research more effectively demonstrates the collective intellectual skills needed by practicing scientists better than conventional methods of science education. There is little doubt that these benefits play a significant role in recruiting undergraduates to major in science and to pursue professions in these fields.

A workshop was held at the National Science Foundation (NSF) in Arlington, Virginia from March 30 through April 2, 2003 to assess the interest in and merits and feasibility of creating Undergraduate Research Centers (URCs) in chemistry, communities of institutions that more broadly engage students earlier in their undergraduate careers in research. The workshop was co-organized by Dr. Jeanne E. Pemberton of the University of Arizona and Dr. Moses Lee of Furman University through the assistance of a Steering Committee composed of Dr. Mark Banaszak-Holl, University of Michigan, Dr. Clarita Bhat, Shoreline Community College, Dr. Royce C. Engstrom, University of South Dakota, Dr. Joseph E. Gordon, IBM, Almaden Research Center, Dr. Vallie Guthrie, North Carolina A&T University, Dr. Carlos G. Gutierrez, California State University – Los Angeles, Dr. William F. Polik, Hope College, and Dr. Isiah Warner, Louisiana State University. Dr. Robert L. Lichter of Merrimack Consultants, LLC served as an observer of the workshop and Dr. Jane C. Love of Furman University served as the writer for the workshop.

The motivating premise of this workshop was that the creation of communities of institutions that more broadly engage younger students (particularly freshmen and sopho-

mores) in research experiences will attract a larger and more diverse student body to chemistry and related disciplines. Research projects conducted within these communities could be more broadly defined than the traditional mentor-student apprenticeship model in order to be better "titrated" to the skills of such students as well as to be consistent with available facilities and instrumentation. Appropriate activities for such a model might include traditional faculty-initiated research projects in addition to carefully designed discovery-based laboratory exercises, or basic research projects that support classroom or laboratory curriculum development, among others. The objectives of the workshop were to: 1) define and refine the problem of enhancing and expanding the opportunities for undergraduate research, particularly at lower levels of the curriculum; 2) consider alternative models of undergraduate research through presentations of model programs; and 3) formulate specific recommendations for a National Science Foundation program solicitation for URCs.

Eighty-four (84) educators and scientists representing a broad array of stakeholders from research universities, predominantly undergraduate institutions, comprehensive universities, community colleges, high schools, government laboratories, industry, funding agencies, and foundations were invited to participate in this workshop. The workshop featured seven plenary talks to present existing models for novel undergraduate research programs and small group discussions to facilitate the exploration of issues pertaining

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ACS Directory of Graduate Research 2003 Released!

The ACS *Directory of Graduate Research* 2003 and DGRweb 2003 are now available! Print copies of the Directory can be purchased online at <http://chemistry.org/store> or by calling the ACS Office of Society Services at 1-800-227-5558. For more information on purchasing DGRweb, visit <http://chemistry.org/education/DGRweb>.

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to the development of URCs. Participants considered the value of research for undergraduate students and explored alternative models for delivering research opportunities to a wider audience than is currently served by the traditional model of undergraduate research, including students earlier in their undergraduate careers, students at community colleges, and students at institutions in rural locations. The primary hypotheses of the workshop were that: 1) research experiences enhance the quality of undergraduate science education and the resulting motivation of students to pursue careers in the physical sciences; 2) undergraduate research experiences need to be more widely and equitably accessible to students at all levels of the curriculum and at all types of postsecondary institutions; and 3) exposing students to research at an earlier stage in their undergraduate careers (or even at the secondary level) is beneficial both in terms of improving the quality of education and recruiting students to careers in science.

The first session featured Dr. Karen Morse, President of Western Washington University, as the plenary speaker. Her presentation considered the role of research activities, broadly defined, in contributing to the intellectual development of undergraduate students, increasing the number of undergraduates that pursue careers in science, technology, engineering and mathematics, and the development of the scientific work force. The populations of students that are or could be affected by participation in research activities were considered, as were the needs of these respective populations and how their education could be enhanced through participation in research. Finally, barriers to achieving this enhancement were considered. The second session featured two presentations considered the traditional model of undergraduate research that is done predominantly with upper class students (*i.e.*, juniors and seniors), the strengths and weaknesses of this model, and barriers that have made this traditional model largely inaccessible to significant segments of the undergraduate population. These presentations were made by Dr. Michael P. Doyle of the University of Arizona and Dr. Elaine Seymour of the University of Colorado at Boulder. The third session followed with presentations by Dr. Pam Mills of Hunter College of the City University of New York and Dr. Ray Turner of Roxbury Community College that considered mechanisms for broadly increasing participation in research activities and strategies for interfacing with other communities who could benefit from access to or enhanced undergraduate research activities. The final session considered the “nuts and bolts” aspects of establishing, operating, assessing, and sustaining broadly-based undergraduate research programs with presentations from Dr. Carlos Gutierrez from California State University at Los Angeles and Dr. Sandra Gregerman of the University of Michigan. Critical barriers and pressure points that inhibit implementation of such programs, and essential resources that would allow these barriers to be surmounted were explored. Criteria that define the success of such programs were articulated,

and strategies for assessing this success were considered. Mechanisms for resource identification to allow these programs to become self-sustaining were also discussed.

A consensus vision on URCs evolved during the course of the workshop. Within this vision, several themes emerged that highlight the philosophical values embedded in the concept of URCs. One central theme was that of collaboration: participants agreed that URCs should bring institutions with divergent missions together to their mutual benefit. A second strong theme that emerged was that, as often as possible, students should be involved in real research and actively contribute to the production of new knowledge. The utility of community-based research experiences in attracting students to the sciences, particularly at urban and nonresidential institutions, was recognized in this context. While it was agreed that URCs should focus initially on expanding research opportunities for freshmen and sophomores, participants articulated an expansive vision in which URCs support research-based learning “from cradle to grave,” from elementary school to civic involvement within the local community. Finally, the themes of institutionalization of the culture of research as the cornerstone of scientific literacy for all students and curricular reform necessary to successfully support such a vision of URCs were also emphasized. Despite its focus on a seemingly limited problem—improving research opportunities for undergraduates early in their academic experience—the concept of URCs clearly represents the kernel of a comprehensive vision for undergraduate education, one with the potential to transform it from an exclusive “ivory tower” into a vigorous and dynamic forum of inclusiveness and engagement for a larger group of students than is currently served.

The workshop final report, *Exploring the Concept of Undergraduate Research Centers: A Report on the NSF Workshop*, details the outcomes of this workshop in the form of summaries of the plenary talks and highlights of discussions that took place during small group breakout sessions. A compendium of undergraduate research program descriptions that embody one or more of the central principles of the URC concept is also included as a useful resource of ideas for the community as it seeks to weave research experiences into the fabric of undergraduate education in chemistry at all levels of the curriculum. This report also contains the consensus recommendations for the development of URCs resulting from workshop discussions that were respectfully submitted to the National Science Foundation for their consideration. An electronic version of the workshop report can be obtained for free from the workshop web site (<http://urc.arizona.edu>). This site also contains videos of six of the seven plenary presentations along with slides used by the presenters. Hard copies of the workshop report can be obtained by request from Dr. Jeanne E. Pemberton at the University of Arizona (pembertn@u.arizona.edu).

The ACS Directory of Graduate Research Celebrates its 50th Anniversary

The recent release of the “ACS Directory of Graduate Research” 2003 marks the 50th anniversary of the Directory, first published in 1953 by the ACS Committee on Professional Training (CPT). The DGR has grown dramatically over its lifetime from including approximately 2000 faculty members from over 150 chemistry and chemical engineering programs in the early editions to 10,522 faculty members from 669 chemistry, chemical engineering, biochemistry, medicinal and pharmaceutical chemistry, polymers and materials science, marine science, toxicology, and environmental science programs in the 2003 edition.

The ACS CPT was established in 1936 with the objective to maintain and improve the quality of postsecondary chemical education in the United States. During the first ten years of its existence, CPT worked tirelessly to set up and implement a process for approving undergraduate chemistry programs at colleges and universities across the U.S. By the mid-1940s the ACS approval process was up and running smoothly at the undergraduate level, so the Committee turned to graduate programs.

The discussion of graduate education began by considering whether an approved list of graduate programs should be compiled. The Committee Secretary was repeatedly bombarded with requests for information by undergraduates searching for a graduate school, therefore it was thought that such a list would serve these undergraduates, as well as to promote and improve the quality of graduate education in the United States. CPT did not take such a decision lightly, so the Committee conducted a series of surveys on the quality of doctoral education in chemistry. The Committee surveyed three target groups: chairs of doctoral granting chemistry programs, doctoral degree recipients who went directly into industry after graduate school, and industrial employers. Each group was asked a variety of questions to evaluate the quality of Ph.D. training at that time. After the results of these surveys were collected, the Committee began to seriously discuss producing a list of approved graduate programs in chemistry.

The idea of approving graduate programs was extremely controversial at the time, so CPT confidentially asked over 400 academic and industrial chemists to rate the quality of graduate education in chemistry at every chemistry doctoral-

degree-granting institution for which he or she felt qualified to give an opinion. CPT received and reviewed over 300 highly variable responses to this survey and it quickly became apparent that approving graduate programs would not be an easy task. As CPT wrestled with this issue, they received a suggestion to at least publish a list of chemistry doctoral thesis titles from Ph.D.-granting institutions in the U.S. so that undergraduates searching for a graduate school could get a sense of the type of work done at any institution they were interested in. The Committee liked the idea, so in late 1952, CPT, in collaboration with *Chemical and Engineering News*, distributed “Titles of Theses Submitted for Doctoral Degrees in Chemistry and Chemical Engineering at American Educational Institutions”. This early predecessor to the DGR was about 50 pages long and contained no departmental information or lists of faculty; with the exception that each student’s thesis was listed with his or her advisor. During preparations for the next edition, the book “Scientific Research in British Universities, 1951-1952” was brought to CPT’s attention.

“Scientific Research in British Universities” contained far more information than CPT’s similar publication, such as a list of faculty and the fields of research for each. CPT thought that this model, with a few modifications, would make a much more useful publication and with that, the concept for the DGR was born. The first edition in 1953 was titled “Faculties, Publications, and Doctoral Theses in Chemistry and Chemical Engineering at United States Universities”, which could be purchased for \$2.00 each. After the 1953 release, CPT debated the frequency of publication, eventually deciding on a biennial cycle. In 1955 the title “American Chemical Society Directory of Graduate Research” was adopted, and the popularity of the Directory exploded. Additional sections, such as biochemistry in 1957, were added, as needed, in response to overwhelming demand. Over time CPT decided against evaluating graduate programs but continued production of the DGR.

During the past 50 years the DGR has seen quite a few changes; new sections were added, the format was altered to accommodate the growing interdisciplinary nature of the chemical sciences, and a web-based version is now available. As the DGR looks forward to another 50 years, please send us your comments and suggestions for improving the DGR to dgr@acs.org.

Council on Undergraduate Research

The Council on Undergraduate Research invites graduate students and postdoctoral fellows who are involved in research with undergraduate students to take advantage of the many opportunities CUR offers. Graduate students and postdoctoral fellows beginning careers involving undergraduate research will benefit from CUR’s publications and programs. CUR publications address issues related to undergraduate research, and those beginning an academic career will want to read “How to Get a Tenure-Track Position at a Predominantly Undergraduate Institution,” “How to Get Started in Research,” and “How to Mentor Undergraduate Researchers.” CUR offers a mentoring service to graduate students and postdocs, providing them with faculty mentors within their field of study. CUR meet-

ings, such as the Proposal Writing Institute, can provide graduate students and postdocs with valuable insight, advice, and networking opportunities. Visit CUR’s web site at www.cur.org to order publications, learn more about our meetings and programs, and find membership information.

A recent CUR White Paper entitled “Preparing Future Faculty Members for Careers at Primarily Undergraduate Institutions” outlined CUR’s recommendations for the ideal inclusive research and teaching experiences that best benefit graduate students and postdocs. The White Paper also addressed the best experiences to optimize collegial skills. The complete text can be found at http://www.cur.org/wp_facultycareer.html.

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