The Role of Research Experiences in the ACS Certified Degree

Role of undergraduate research in the certified chemistry major, Thomas Wenzel, Bates College

Undergraduate research provides an experience in which students can gain and exercise critical thinking and problem solving skills. An effective research experience also provides students with the opportunity to integrate chemistry concepts learned in classes into the broader context of a research question. Finally, it provides students with the opportunity to investigate previously unanswered questions or to synthesize and study new molecules. In recognition of the important role research plays in the education of professional chemists, the guidelines for bachelor's degree programs allow research to count for up to 180 of the 400 laboratory hours or for as much as four semester credit hours toward the four in-depth courses required for certification. In this talk, the role of research in the undergraduate curriculum and the expectations of the experience for certified chemistry majors will be explored. Some new resources that will help departments with safety considerations specific to student work in a research laboratory undertaking independent projects will be described.

Research experiences in the chemistry and biochemistry curriculum at Barnard College: A structure that supports student learning, faculty development, and safety for a diverse population, Andrew Crowther and Rachel Austin, Barnard College

Undergraduate research plays a pivotal role in the chemistry and biochemistry programs at Barnard College. A number of institutional and departmental structures create a safe and stimulating environment for student research. The college created the Summer Research Institute (SRI), in which research students from all the sciences meet weekly for seminars and training sessions (sessions include literature searching, programming and safety). The institute culminates in a large poster session in which all summer research students present. A science pathways scholars program (SP)2 program was recently funded by the Sherman Fairchild foundation. Elite students from groups traditionally underrepresented in the sciences are brought to campus for a week before they begin their first year and then are given summer research fellowships for each of the three summers that they are matriculated students. The (SP)2 program is just one of several programs designed to help diversify the population of science majors at Barnard. Several other scholarships are available specifically for students from low income families to enable them to do summer research. The college also provides free housing for students doing summer research and a fund, for which the institution is constantly fund-raising to support, to pay the costs of student stipends. In addition to the well-structured summer research program, the chemistry department has created a monthly PI meeting in which faculty members who run research groups take turns presenting and discussing their research, which helps to create and sustain a vibrant intellectual community.

Undergraduate research: for CPT approval and for preparing minority students for success in PhD programs, Carlos Gutierrez, California State University Los Angeles

Demographers expect that by 2043 there will be no majority group among US populations. That future has already arrived in California, which is today where the nation will be by midcentury. If the nation is to continue to lead in chemistry- and molecular science research and maintain its economic competitiveness, all American populations must participate as PhD-level molecular scientists and contribute their creative efforts at a high level. California State University, Los Angeles is a minority serving urban institution whose Department of Chemistry and Biochemistry uses undergraduate research to satisfy CPT requirements and also to develop the careers of our undergraduates to a high level so they are prepared to succeed in post-baccalaureate ventures, including pursuing the PhD. Through its Minority Opportunities in Research (MORE) program we have developed intense undergraduate research training programs that have been reverse-engineered form the characteristics, habits and skills of highly successful graduate students in top PhD programs. Its intense training programs have yielded outstanding results. In the past decade, some 70% of MORE undergraduates have subsequently entered and succeeded in top PhD programs. In its most recent listing, the National Science Foundation ranked Cal State LA as the top baccalaureate institution of origin of Hispanic science PhD recipients among all predominantly undergraduate and masters colleges and universities in the continental US. Chemistry and Biochemistry alumni are the largest contributors to this ranking.

Five phases for integrating the scientific method and communication skills with research experiences, Jeffrey Evanseck, Duquesne University

The scientific method is a vital part of the undergraduate research experience, typically taught one-on-one by a research mentor. We have devised a pedagogy that develops a research skill set in the classroom to deepen and expand laboratory research experiences. A five-phase approach to the scientific method was implemented in an undergraduate research course focused on written and oral communication. Students present and submit a written document on (1) scientific motivation and necessary background, (2) hypothesis and critical thinking, (3) specific aims and connection to the hypothesis, (4) methods and instrumentation with error analysis, and (5) results, interpretation, conclusions, and future work. Faculty, graduate students, mentors, and peers evaluated student performance. The process concluded with submission of a drafted manuscript, incorporating the five phases. Results indicate that speaking and writing abilities and student self-assessment of abilities improved through the five-phase program. The importance of focus and reflection upon specific elements of the scientific method are underscored and considered to be significant factors in the pedagogical success.

Improving undergraduate education through innovative research experiences, Nicholas Salzameda, California State University Fullerton

A strong research culture has always been, and continues to be, a cornerstone of the department of chemistry & biochemistry at California State University, Fullerton (CSUF). The department offers degrees in biochemistry (B.S.), chemistry (B.S. or B.A. or M.S.) and currently houses 750 undergraduate and graduate students. Faculty members are expected to teach, advise and mentor undergraduate students in the classroom and research laboratory. All chemistry and biochemistry majors are required to complete an independent research project, under the direction of a research active faculty member for a minimum of two semesters. Students have access to a variety of research equipment and are active in the research laboratory through the academic and summer months. As a faculty member I run a productive research program in the field of medicinal chemistry with undergraduate students performing a majority of the research activities. In addition to working with CSUF students, I have also provided research experiences to community college and high school summer students. Authentic research is a positive experience for students as it provides hands-on training that is extremely important in a student's educational development. With 56% of CSUF's students being the first in their family to graduate college, it is important to provide a welcoming and innovating environment, such as being a part of a research group, where students can learn, seek advice, or consider the next step in their academic or professional life. Undergraduate research provides an unparalleled educational experience that makes a difference in students' lives. As the department grows additional research opportunities are needed to augment traditional research laboratories. New courses have been implemented that integrate teaching and authentic research to provide a synergistic experience. The department has also made a priority to increase the number of student internship opportunities with local biotechnology companies. As scientific fields are rapidly advancing into more interdisciplinary areas, research and curriculum must adapt to prepare graduates with marketable industry skills.

Starting a research program at primarily undergraduate institution: Practical strategies and supportive policies, Michelle Kovarik, Trinity College

An authentic research experience is an important, sometimes career-changing component of undergraduate education at diverse institutions. At a primarily undergraduate institution (PUI), undergraduate research extends beyond this curricular enrichment into knowledge creation. In the absence of graduate students and postdoctoral scholars, research programs at PUIs are driven by undergraduates' results, potentially changing the role and outcomes of undergraduate research in the curriculum. This undergraduate-driven model of research has several benefits for students (such as greater project ownership and enhanced development of associated professional and technical skills), but also places unique demands on faculty leading research programs at PUIs. In a more teaching-intensive environment, it can be particularly challenging to balance constraints of time and funding while promoting positive student outcomes and producing publishable scientific results. In this talk, I will describe my department's approach to the challenges and opportunities of undergraduate research at Trinity College, a small private liberal arts college. In addition to highlighting specific aspects of our program, I will draw on interviews of research-active faculty at other PUIs and my own experience developing an independent research program since

starting my faculty position in 2013. My goal will be to suggest practical strategies for other junior faculty and supportive policies for department chairs and other administrators.

Use of active learning pedagogies and undergraduate research experiences to promote student success in chemistry at North Carolina A&T State University, Sayo Fakayode, North Carolina A&T
Stimulating undergraduate students' learning in chemistry can only be achieved and sustained through provision of active learning and hands-on research experiences for students. The Department of Chemistry at North Carolina A&T State University (N.C.A&T) in conjunction with the STEM Center for Excellence for Active Learning in the College of Science and Technology has provided resources and incentives to promote active learning laboratory environments and robust undergraduate research experiences for its majors and other STEM degree seeking students. First, several undergraduate STEM laboratory courses have been redesigned and transformed to promote implementation of new curriculum initiatives to active learning and student engaging environments. Active Learning initiatives include inquiry and problem-based learning strategies. N.C.A&T has also promoted the use of early involvement of undergraduate students in research experiences during the academic year and summer that integrates technical training, communication skills, team-work, professional development, and a career pathway program to retain and graduate students in STEM. Besides, professional development programs, support has been provided for faculty members to engage in the development of interdisciplinary, active learning and hands-on research initiatives for their STEM majors. In general, the students that have participated in active learning and hands-on research are more excited about their degree program and have demonstrated improved critical thinking, problem solving, communication skills, and a spirit of teamwork. Also, implementation of active learning and hands-on research experiences in the classroom and laboratory has significantly improved the persistence and retention of students. In addition, chemistry majors as well as other STEM students that have participated in active learning and hands-on research are more competent and confident in the use of lab chemicals, reagents, glassware, and analytical instruments. The design, implementation of selected active learning initiatives and undergraduate research strategies to promote student learning will be highlighted. Also, the assessment of these strategies on the students' learning and their experiences in active learning and hands-on research will be discussed.

It's research that makes the Gator chemistry major, Lisa McElwee-White, University of Florida
The University of Florida is among the nation's most academically diverse public universities, with 16 colleges and more than 200 research centers and institutes. As a part of the institutional tradition for excellence in undergraduate education, UF has leveraged the campus research effort to establish significant externally- and internally-funded undergraduate research programs, resulting in a variety of opportunities utilized by our chemistry majors. Examples include the HHMI Science for Life program, the UF Beckman Scholars Program, the University Scholars Program, the Emerging Scholars Program, and international NSF-REU sites.