

“Cultivating a passion for learning should remain a first priority at all levels of education. The great physicist I. I. Rabi said that when he was a little boy, his mother would ask him, “Did you ask any good questions at school today?” Involving undergraduates in research and preparing them for these research experiences by engaging them in the types of activities described in these chapters ultimately helps them develop the ability to “ask good questions”. These are the questions that will lead to the next frontiers in science. Developing these leaders is a strategic initiative of the highest priority for our Nation.”

*Congressman Sherwood Boehlert
Chairman of the House Science Committee*

“In this era of globalization, understanding what it means to create new knowledge should be a core competency for today’s college student. This fine collection of exemplars and perspectives assembled by the Council on Undergraduate Research will inspire students, instructors, and administrators to develop and test new curricular models that can build our national capacity for research and innovation.”

*Arthur B. Ellis
Vice Chancellor for Research
University of California, San Diego*

“The engagement of undergraduate students in research promotes the strongest form of curriculum, but also how programs can be built, sustained, and scaled to new levels. This new book by CUR goes a long way in helping institutions to develop a road-map for success in making undergraduate research an integral part of the research and educational expectations for students and faculty alike.”

*James M. Gentile, Ph.D.
President, Research Corporation*



Council on Undergraduate Research

Developing & Sustaining a Research-Supportive Curriculum: *A Compendium of Successful Practices*



Council on Undergraduate Research

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Executive Summary

The Issue

American economic strength in the 21st century will depend upon our continued ability to lead the global community in areas of science and technology. Strategies to achieve and sustain this strength have been articulated in the form of specific recommendations to federal policymakers laid out in the recent report compiled for the National Academies of Science titled “Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future”.

Beyond economic strength, educators and policymakers must take seriously the growing distrust, misunderstanding, and skepticism of modern science. An appreciation of “how science is done” lies at the heart of an educated citizenry that we expect and, in fact, demand to engage in issues and debates that regularly employ technical and scientific arguments. Scientific and technological literacy is much more than a mastery of principles or a collection of facts. The root of science literacy is an understanding of the process that led to the widespread acceptance of our current understanding of the physical and natural world.

Creative strategies to cultivate these “habits of mind” in our future leaders have been implemented at a wide range of institutions that serve a diverse array of students. Some of the most successful practices have recently been published by the Council on Undergraduate Research in an edited volume titled “Developing & Sustaining a Research-Supportive Curriculum: A Compendium of Successful Practices”. Engaging students in open-ended investigations that invite them to exert their own creativity and insight into the interpretation of data (evidence) is an opportunity to ignite in them the passions and intellectual curiosity that fuel scientific discovery. These are the “hands-on” and “minds-on” activities that can reverse the well-established decline in students choosing careers in science, mathematics, and technology.

The Approach

The Council on Undergraduate Research (CUR) supports faculty development for high-quality undergraduate student-faculty collaborative research and scholarship. CUR believes that the best way to capture student interest and create enthusiasm for a discipline is through research in close collaboration with faculty members. Undergraduate research experiences provide students with a conceptual understanding of their disciplines, while cultivating critical thinking and problem solving skills that transcend disciplinary learning. The connections between learning in the classroom and the capacities needed to become contributing members of society develop when students define problems, seek to understand the problem, develop strategies to address the problem and take action to implement these strategies. Such research activities have the potential of revealing new discoveries and new approaches to the challenging issues confronting contemporary society. The 500 institutional members of the Council on Undergraduate Research have made significant investments in undergraduate research because of their belief that undergraduate research is one of the best ways to align intellectual development and practical problem solving.

Highlights of Effective Practices to Develop a Research-Supportive Curriculum

- Problem-based learning where an authentic problem reflecting complex, real-world situations initiates the learning process among a group of students who are engaged in a student-centered, cooperative, and interactive exploration and design of a suitable solution.
- Project-based laboratories involving inquiry-driven scientific investigations that allow an individual working independently or a team of students working collaboratively to formulate the questions to be addressed and to design the experiments to answer the questions posed.
- A collaboration among faculty at an array of institutions to select, develop, and field test a collection of inquiry-based experiments involving particular organisms that lend themselves to research-based experimentation at all levels of the curriculum.
- A year-long learning community of students and faculty focused on a large-scale team-based project with an emphasis on a single complex environmental/Earth-system problem requiring a cross-disciplinary approach to address aspects of science, engineering, public policy, economics, politics and social issues.
- The use of geographic information system (GIS) technology as a teaching and learning tool to help students visualize complex spatial relationships in a variety of disciplines.
- An online course design tutorial that directs faculty to set overarching and ancillary skills goals for their students and then to choose specific content through which the overarching goals can be accomplished.
- Strategies for integrating activities and exercises to develop information research skills throughout a curriculum using a scaffolding approach that emphasizes iteration through multiple, sequential assignments.
- The use of institutional support services to facilitate the development of research-supportive curricula including the use of writing centers and undergraduate research offices.
- The use of facility design strategies to optimally encourage research activity and collaboration and facilitate the presentation and celebration of research findings.
- The use of ladder teams to develop a collaborative research community, utilize the expertise and leadership skills of undergraduates, and lend a sense of continuity to projects over an extended period of time.
- The design of an introductory interdisciplinary inquiry-driven laboratory designed to bridge laboratory experiences from biology, chemistry, and physics and to illustrate the commonality of investigative methods and laboratory techniques in these sciences.
- The use of local natural resources - a river watershed, an environmental field station, a nature park or arboretum - as a platform for teaching and research.

Relevance

America’s competitiveness in the global economy will depend upon the intersection of our ability to innovate in the business sector and the education of our future scientists and engineers. CUR members are working to revitalize the science curriculum on their campuses to include rigorous, hands-on experiences in the classroom so that more students will study science and choose scientific careers. *Developing and Sustaining a Research-Supportive Curriculum* emphasizes the importance of the collective efforts of the undergraduate community to integrate research and education. By collecting and disseminating multiple examples of effective research-supportive undergraduate programs, the Council on Undergraduate Research aims to encourage faculty and institutions to continue to seek creative, useful, and significant ways to promote “learning through research”.