cpt newsletter
Committee on Professional Training

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Proposed Revision in Chemistry Education Option and New Chemistry Education Minor

In June 2001, the Committee on Professional Training (CPT) sponsored a two-day workshop on the status and future of the ACS-approved Chemistry Education Option. Recommendations from the workshop led to proposals from CPT for revised requirements for the ACS-approved Chemistry Education Option and for a new approved chemistry education minor. The workshop also suggested other actions that might be taken by other parts of ACS to address the critical need for high school chemistry teachers. This article reports on the June 2001 workshop and details the proposed new requirements for the Chemistry Education Option and for the minor.

Background

The Chemistry Education Option for ACS-approved programs and student certification has been offered since 1988. It was designed to provide a route for students planning to teach at the secondary level to receive a certified degree in an ACS-approved program while simultaneously obtaining teaching credentials. Since it was instituted, very few students have been certified under the Chemistry Education Option. Consequently, CPT sponsored the 2001 workshop to assist in an extensive reevaluation of the degree requirements of this option, which was also part of the sunset review of all of the ACS-approved degree options. Workshop participants, representing four of the six ACS-approved Chemistry Education Option programs, CPT, and the broader chemical education community, assessed the current requirements for degree certification and how they might be modified to encourage many more participants in the program while ensuring that teachers of chemistry at the secondary level have an adequate background in chemistry.

The Workshop

The meeting began with an overview of the agenda and goals of the workshop by CPT member Dr. Margaret V. Merritt, followed by Dr. Jerry Mohrig's (CPT) review of the development of the Chemistry Education Option. Representatives from four departments with ACS-approved Chemistry Education Options gave presentations on their programs: Dr. Barbara Sawrey from the University of California at San Diego, Dr. Donna Amenta of James Madison University, Dr. Pushpalatha Murthy of Michigan Technological University, and Dr. Richard Schwenz of the University of Northern Colorado. These workshop participants described their overall chemistry programs and the role of the Chemistry Education Option within them, the hurdles faced by their institutions in maintaining the option, the place of their institutions within their respective states in terms of teacher certification, and data on the number of high school teachers in their states and the number of those with backgrounds in chemistry. To provide perspectives from chemistry education programs that do not have ACS approval, three participants (Dr. John W. Moore of the University of Wisconsin-Madison, Dr. Glenn Crosby of Washington State University, and Dr. George Palladino of the University of Pennsylvania) made presentations on typical programs for students who eventually become certified by their states to teach high school chemistry and the particular strengths and weaknesses of those programs. Each formal presentation was followed by a general discussion involving all participants.

Dr. Kathryn C. Scantlebury from the National Science Foundation and the University of Delaware and Dr. Jerry L. Sarquis of Miami University of Ohio began the second day of the workshop with presentations on how the increasing teacher certification and licensure requirements affect the quality of teacher preparation. Break-out groups then met to consider more fully the key issues that emerged from all formal presentations and subsequent discussions. The full group reconvened to discuss the reports from each of the break-out groups and develop final recommendations for CPT and ACS. There was general agreement that chemistry faces a major challenge due to the impending shortage of qualified high school chemistry teachers. Suggestions regarding the role that the Society might have in attracting, encouraging, and rewarding high school chemistry teachers and improving their skills are now under active consideration.

Upcoming CPT Events

223rd ACS National Meeting, Orlando, FL

- Sunday, April 7, Morning Session—Educating High School Chemistry Teachers: The Role of CPT
- Sunday, April 7, noon–1 p.m. in the Sheraton World Resort—CPT Open Meeting

17th Biennial Conference on Chemical Education, Bellingham, WA

- July 28-August 1, Exact date and time TBA. CPT presentation and open meeting on the Chemistry Education Option. See the BCCE website for details: http://chem.wwu.edu/acs/bcce/.

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Workshop Outcomes and CPT Proposals

The full CPT has carefully considered the workshop recommendations regarding the role it can play in secondary chemistry teacher training. This consideration has led to a proposed revision of the requirements for the Chemistry Education Option and a new ACS-approved Chemistry Education Minor. This minor recognizes that currently a large number of high school chemistry teachers have undergraduate degrees in other science disciplines and relatively weak preparation in chemistry. The new minor would provide a mechanism for students planning to become certified teachers in secondary science fields other than chemistry to obtain a more substantial preparation in chemistry. The background in chemistry obtained by students completing this minor would enhance their teaching in their major field and ensure that they have adequate background for teaching chemistry at the secondary level.

The goal of both proposals is to increase the number of students electing to prepare for secondary school chemistry teaching and to ensure that all future chemistry teachers at this level have an adequate background in the discipline. Action by the ACS-CPT at this time seems critical given the changing state requirements for students to become secondary science teachers and the large number of retirements of current chemistry teachers.

1. Proposed Requirements for the ACS-approved Chemistry Education Option

The Chemistry Education Option would require the same first two years that any other certified major would take, typically introductory and organic chemistry, with the exception that only one semester of organic chemistry laboratory would be required. Beyond that, the program would include comparable exposure to all additional areas of chemistry, including analytical (a rigorous course in environmental chemistry might replace analytical), inorganic, physical, and biochemistry. Coverage in each area should be equivalent to at least a one-semester course. Students would complete an in-depth study of one area of chemistry, which could include an additional course in one of the traditional areas of chemistry, an advanced course for which the student has satisfied prerequisites, or research in one of the areas.

Students would also complete the equivalent of three semester credit hours in chemistry methods, including laboratory experimental design and preparation, stockroom procedures, safety, disposal of chemical waste, teaching assistant experience, and the literature of chemical education. This requirement may be met through various means, including independent study, teaching assistantships, specific methods courses, and interdisciplinary approaches.

A minimum of 35 semester credit hours of chemistry would be required. The total chemistry lab hours for the Chemistry Education Option would be no fewer than 300. Ancillary courses would include one year of calculus and one year of physics with laboratory.

Students electing this option are expected to complete courses in education needed for certification as defined by state requirements.

2. Proposed Requirements for a Chemistry Education Minor

This minor would include a minimum of 23 semester credit hours (or equivalent). Two or more areas of chemistry would be chosen beyond the first-year courses in chemistry from the following: analytical, biochemistry, environmental, inorganic, organic, and physical. This minor would include a minimum of 200 total hours of laboratory experience in chemistry, with at least two different areas represented beyond first-year chemistry. Eight semester credit hours of physics would also be part of the minor.

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Call for Comments

CPT is now seeking comments from the chemistry community on these two proposals. In addition to the specific requirements of the proposals themselves, of particular interest to CPT is which schools should be eligible to offer the Chemistry Education Minor: Should all ACS-approved chemistry departments be able to offer this program following review and evaluation by CPT, or should it be restricted to those departments offering the Chemistry Education Option for degree certification? Comments on both proposals should be sent to the Office of CPT at cpt@acs.org or to the Secretary of the Committee, Cathy Nelson, Committee on Professional Training, American Chemical Society, 1155 16th Street, NW, Washington, DC 20036.

UNDERGRADUATE RESEARCH ACS-CPT SUPPLEMENT

Research can be the most rewarding aspect of an undergraduate chemistry degree. Students grow both professionally and personally in ways that are not possible through traditional classroom and laboratory classes. In addition, faculty members and chemistry programs are strengthened through the existence of student-faculty collaborative research. Since research unifies and extends the ACS-approved core chemistry curriculum, the Committee on Professional Training strongly encourages making research available to undergraduates as an advanced course option.

Student Benefits

Through undergraduate research, students develop problem-solving skills in a fashion that no other educational experience can match. Research requires students to reach beyond their classroom textbooks and use the chemical literature to learn about their research topic. Students learn to design their own experiments and make observations where the outcome is not already known. Their formal education gains added relevance when they apply classroom knowledge and laboratory skills in a research setting. Extensive hands-on use of research-quality equipment further develops their experimental skills and techniques. Students learn how to interpret results and draw conclusions from their own experiments. Finally, preparing both oral and written presentations of their research work completes the cycle of science by illustrating how their contribution to the scientific knowledge base permits other scientists to build upon their efforts.

In addition to learning useful scientific skills, students involved in research develop personal traits that are critical for success in their future professions, be they in science or elsewhere. Research encourages students to develop a spirit of open inquiry and stimulates their personal creativity. Research students gain the confidence to work independently and make sound judgments, yet they learn to ask for guidance when appropriate. The necessity of developing new

approaches to failed experiments develops persistence and a strong work ethic, and the necessity of repeating successful experiments before publication causes students to recognize the importance of producing work of the highest standard.

Because research often occurs in teams, students learn to interact with their peers in a collaborative setting. They also learn to work with their mentors and interact with other faculty in a professional manner. By doing original science and working with established scientists, research students learn what it means to be a scientist. Furthermore, students become more employable by being involved in research. Potential employers greatly value the skills that are developed through research and actively seek students with research experience.

Faculty and Program Benefits

An undergraduate research program is valuable for the participating faculty as well as the students. Active research is the most effective means of keeping faculty up-to-date in their fields. Research invigorates the faculty intellectually, which leads to increased enthusiasm, better morale, and improved teaching. Research activity emphasizes that science is not static. This encourages the faculty to change and improve their course offerings.

Undergraduate research also produces programmatic benefits to chemistry departments. External funding for research brings new equipment and facilities into the department. It is especially effective when equipment can be used in both research and teaching, so that all students receive the benefit of research-quality instrumentation. An active research program is also a key element in attracting the most talented individuals to join a faculty, which directly strengthens the overall program.

Required Institutional Commitment

A successful undergraduate research program requires a committed faculty, supportive administration policies, and appropriate resources. First, the department faculty must view research as an essential aspect of their program. Measures of commitment include the writing of research proposals and the publication of research results. Second, the institution must recognize that the tremendous benefits of undergraduate research cannot occur without significant faculty effort. In successful undergraduate research programs, the administration recognizes undergraduate research as a valid method of teaching and gives some form of credit to faculty for their undergraduate research activities, usually through teaching commitments that recognize research involvement. Third, the program must have both adequate financial resources and appropriate space in which to carry out research. Funds should be available for supplies and stipends, matching of equipment grants, faculty and student travel to professional meetings, and sabbatical leaves for scholarly growth. Dedicated facilities for research that meet all safety guidelines must exist. Finally, the Committee on Professional Training notes that extensive use of part-time or non-tenure-track teaching faculty by an institution reduces the fraction of research-active faculty and the number of research opportunities for students.

Characteristics of Undergraduate Research

Research is the development of new knowledge or understanding in order to advance science. While the specific areas of research vary immensely in the chemical sciences and in chemical education, there are some traits that are common to undergraduate research in general.

Undergraduate research is conducted with a faculty advisor or mentor. The student's research project is typically based on the faculty mentor's research interests, an arrangement which allows the student to draw upon the mentor's expertise and resources and also allows the faculty mentor to develop a productive research program. The mentor meets regularly with the student to make research plans, assess risks associated with the proposed research, and review results. The student is encouraged to take primary responsibility for the project and to provide substantial input into its direction. The student-mentor relationship also builds student confidence, offers encouragement when necessary, and provides guidance and assistance for the student's future education and career development.

Undergraduate research should be envisioned as publishable in a peer-reviewed journal. Research builds upon the previous accomplishments of other scholars. For research to have any meaning or effect, it must be communicated to the scientific community. Peer review is the generally accepted means of monitoring and ensuring the quality of research. While not every undergraduate research project will result in a peer-reviewed publication, it should be the intent of each project to contribute to such a result. When an individual student research project is not of wide enough scope for an entire publication, it can often be combined with other undergraduate research projects into a more comprehensive study that merits publication.

While the nature of each project depends on the specifics of the research, an ideal undergraduate research project

- has a clearly communicated purpose and potential outcomes,
- has well-defined objectives and methods,
- is substantial in scope (as opposed to a collection of small projects),
- has a reasonable chance of completion in the available time,
- requires contact with the chemical literature,
- avoids repetitive work,
- requires use of advanced concepts, and
- requires a variety of techniques and instruments (not exclusively library work).

Finally, undergraduate research should culminate in a comprehensive written report. Oral and poster presentations are an extremely useful step in this process. However, a research project should not culminate solely in an oral presentation, as it would not become part of the archived body of knowledge. A written report adds to the permanent scientific knowledge base and can be used by subsequent researchers pursuing related projects.

Research in the Guidelines

The Committee on Professional Training highly recommends that research be among the educational requirements of an ACS-certified chemistry degree. Research may be used for some or all of the six semester hours of advanced courses required for ACS certification. Research may also be used for some or all of the advanced laboratory hours needed to reach a total of 500 laboratory hours.

If research is used for an advanced course or advanced laboratory hours, then a well-written, comprehensive, and well-documented research report must be prepared. The faculty supervisor should constructively criticize drafts of the report. A separate supplement provides guidelines for preparing a research report. Oral, poster, and/or computer presentations do not meet this requirement. Student coauthorship on a paper, while highly encouraged, is not a substitute for a comprehensive report written by the student. Examples of student research reports must be included with an institution's five-year report if research is used as an advanced course for student certification.

Research done off-campus and/or during the summer, even though it might not be for academic credit, may count toward certification. In such cases, the student must prepare a comprehensive report that is evaluated and approved by a faculty member of the home institution.

ACS Committee on Professional Training 2002

Dr. Jeanne E. Pemberton
UNIVERSITY OF ARIZONA
(Committee Chair)

Dr. Charles E. Carraher, Jr.
FLORIDA ATLANTIC UNIVERSITY

Dr. F. Fleming Crim
UNIVERSITY OF WISCONSIN–MADISON

Dr. Royce C. Engstrom
UNIVERSITY OF SOUTH DAKOTA

Dr. Billy Joe Evans
UNIVERSITY OF MICHIGAN

Dr. Carlos G. Gutierrez
CALIFORNIA STATE UNIVERSITY, LOS ANGELES

Dr. Jeffery W. Kelly
THE SCRIPPS RESEARCH INSTITUTE

Dr. John W. Kozarich
ACTIVX BIOSCIENCES

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EXXON CHEMICAL COMPANY

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WELLESLEY COLLEGE

Dr. Nancy S. Mills
TRINITY UNIVERSITY

Dr. William F. Polik
HOPE COLLEGE

Dr. C. Dale Poulter
UNIVERSITY OF UTAH

Dr. Elizabeth C. Theil
CHILDREN'S HOSPITAL OAKLAND RESEARCH INSTITUTE

CONSULTANTS

Dr. Dale W. Margerum
PURDUE UNIVERSITY

Dr. Jerry R. Mohrig
CARLETON COLLEGE

AMERICAN CHEMICAL SOCIETY
Cathy A. Nelson*
(Committee Secretary)
1155 16th Street, NW
Washington, DC 20036
(202) 872-4589 (Phone)
(202) 872-6066 (Fax)
E-mail: cpt@acs.org

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