

# Miami University's Ph.D. in Chemistry with Emphasis in Chemical Education

Department of Chemistry & Biochemistry

Miami University  
Oxford, OH 45056

513-529-2813

[www.cas.muohio.edu/chm/](http://www.cas.muohio.edu/chm/)

## *Faculty in Chemical Education*

S. Lowery Bretz, [bretzsl@muohio.edu](mailto:bretzsl@muohio.edu), 513-529-3731

A.M. Sarquis, Professor, [sarquiam@muohio.edu](mailto:sarquiam@muohio.edu), 513-727-3278

J.L. Sarquis, Professor, [sarquijl@muohio.edu](mailto:sarquijl@muohio.edu), 513-529-2819

J.P. Williams, Associate Professor, [williajp@muohio.edu](mailto:williajp@muohio.edu), 513-785-3242

## *About the Program*

A Ph.D. is a research degree awarded to those who demonstrate their ability to make original contributions to knowledge in a field. A Chemistry Ph.D. with emphasis in Chemical Education requires a combination of talents: fluency in advanced levels of chemistry as well as competency in supporting areas such as cognitive psychology and learning theory, statistics, technical communications, computer technology, and behavioral research methods including evaluation.

Miami's Chemical Education Ph.D. program is intended for those interested in becoming teachers of chemistry in situations where a comprehensive knowledge of advanced chemical concepts is required and where acceptable scholarly activity can include the pursuit of chemical education research.



### *What Is Chemical Education Research?*

Research in chemical education can be categorized in four major domains:

- instructional material development and testing (e.g., experiments, demonstrations, and student guides);
- curriculum development and testing (e.g., evaluation methodologies, designing and evaluating new courses or programs of study);
- instructional technology (e.g., development and evaluation of effectiveness); and
- student learning (e.g., identifying and addressing student difficulties in processing chemistry information, problem solving, individual vs. group interactions, assessment methodologies, and applying modern learning theory).

Chemical education research is systematic investigation of the variables that affect the learning of chemistry and of the value of alternative strategies in instruction. Persons with expertise in chemical education research have been responsible for

- creating programs that suit the needs of changing student populations;
- developing, implementing, and analyzing assessment procedures to document student learning outcomes, which have become increasingly important to state and federal agencies;
- developing new materials for use in all aspects of chemistry;
- utilizing and exploiting the special values of instructional technology; and
- adapting methods and materials to enhance learning.

### *Miami faculty in the Chemical Education Division have research interests that include investigating*

- methods of effectively involving students in laboratory-based experiences that increase student motivation, increase transference to concepts presented in lecture, reflect problems encountered in the workplace, and involve active decision-making and formation of experimental design;
- modifications of the traditional lecture/laboratory course presentations and design to involve increased student learning by involving students in doing chemistry outside of classroom experiences, use of lecture experiments and demonstrations, cooperative group work, workshop-style course design, and modular curriculum design and use;
- methods of effectively presenting chemistry concepts to students at different levels of development and with diverse backgrounds, including methods of teaching chemistry to teachers and other adult learners, workshop design and presentation issues, presentation of content within a given context and on a need-to-know basis, different styles of learning chemistry, preparation and training of chemical technicians, and assessment as an integral part of the learning process; and
- elements of material design and presentation necessary to maximize the usefulness of written chemistry materials for the end user, including design of written laboratory procedures for student use and design of supplemental documents for chemistry teachers' use.

### *Guidelines and Expectations of Ph.D. Candidates in Chemical Education at Miami*

This section states the specific requirements for students interested in pursuing a Ph.D. in chemistry with an emphasis in chemical education after completion of a research-based Master's Degree in chemistry. (Those not in this category will be required to undertake at least one semester of research in a traditional area of study.)

- The student must be admitted into the graduate program at Miami and the Department of Chemistry and Biochemistry under the same terms as any other graduate student.
- The student must participate in all placement exams and training programs and satisfy regular Graduate School and departmental requirements.
- The student must have his or her course of study approved by their graduate advisory committee. This must meet the minimum department requirements for the area of concentration (Chemical Education) and breadth requirement noted below.
- The student will complete a minimum of two graduate courses comprised of at least 5 hours within the Chemical Education Division, such as College Chemistry Teaching (CHM 623), Methods in Chemical Education Research: Elements of Effective Teacher Enhancement Efforts (CHM 621), Methods in Chemical Education Research: Materials & Curriculum Development (CHM 622), or selected courses outside the department.
- The student must satisfy the departmental breadth-of-study requirement by completing a minimum of four graduate chemistry courses comprising at least 8 credits outside of Chemical Education, e.g., Analytical, Biochemistry, Inorganic, Organic, and/or Physical. For Chemical Education graduate students, three of these courses should typically be in the student's area of concurrent study, with the fourth being in a different area for breadth.
- The student will participate in departmental colloquia/seminars as well as meetings of the chemical education group. Students should also attend colloquia/seminars that relate to their area of concurrent study and to chemical education.
- The student must pass a departmental comprehensive examination covering chemical education and the candidate's area of concurrent chemistry study.
- The student must pass Ph.D. preliminary and final oral examinations including the preparation of an Original Research Proposal (ORP) as per the departmental and Graduate School requirement. The ORP within the area of Chemical Education requires the development of a document that could be submitted as a proposal to a funding agency. This will typically require justification, an evaluation plan, and a detailed budget explanation.
- The student will fulfill dissertation requirements which allow a student to have significant experience in at least two (but three are typically recommended) of the four areas of chemical education research. At least one of the areas of study must be student learning, while the other(s) will address aspects of material, curriculum, or instructional technology development. (See next page.)
- The student will write and submit an article to a refereed journal.

## *Chemical Education Dissertation*

The dissertation will consist of three major projects. One must be in the area of student learning and the other two from material, curriculum, or instructional technology development.

### **Student-Learning Project**

The students must complete a major project of publishable quality in the area of student learning in chemistry. Possible projects might include determining the effect different presentation styles have on student learning as measured by performance on chemistry examinations and designing ways of determining student misconceptions about a particular concept, testing different methods of challenging these misconceptions, and the results of these efforts on a student's ultimate understanding of the concept.

### **Material, Curriculum, or Instructional Technology Development**

It is typically recommended that each student complete **two** major curriculum development projects selected from two of the following categories: materials development, course development, or instructional technology development. One of these should be in the area of the student area of concurrent study and should include research protocol associated with that area. This concurrent research experience could serve as a model for undergraduate research.

These development projects have the following requirements.

- A testing/revision plan must be outlined and undertaken.
- The materials developed must be used in the course for which they were developed for at least one term. An evaluation must be undertaken and revision plan established. At least one of the projects should undergo the revision and retesting stages.
- At least one of these projects must include a laboratory or computational component.

## *Estimated Time*

It is estimated that the Chemical Education Ph.D. program will take between 3–5 years to complete depending on the background of the candidate (e.g., completion of an MS), course load during the program, the time committed to research, and the dissertation development process.



MIAMI  
UNIVERSITY

O X F O R D O H I O