

Chemistry Education Research Doctoral Scholars Program

Project Overview

Chemistry education is a fast-growing field. Training more students in science, technology, engineering and mathematics (STEM) for a global economy necessitates an understanding of how students learn chemistry and how chemistry instructors adapt to more diverse student populations, which is critical to maintaining students in the discipline. The Chemistry Education Research (CER) Doctoral Scholars Program trains a diverse group of graduate students how to develop assessments of secondary and tertiary students' understandings of core concepts in chemistry. The program is in its 4th year. The goals of the project are to

- Recruit, train, and graduate scholars in CER who specialize in assessment
- Design coursework, K-12 partnerships, research experiences, and mentoring to successfully prepare these scholars for careers in CER
- Create a community of scholars to collaborate and systematically improve assessment of student learning.

A single cohort of six graduate students began their studies at Miami University in Fall 2008. Scholars receive a \$30,000 graduate stipend, tuition and fee waivers, and health insurance for five years. They also receive a laptop computer and funding to present at two conferences each year. Currently, there are four graduate students in the Program whose dissertation research focuses on assessing secondary and tertiary students' understandings of atomic emission, chemical bonding, intermolecular forces, and acid-base reactions.

Like other graduate students in the Department, CER Scholars are required to choose a cognate area (i.e., organic, inorganic, analytical, physical, or biochemistry), take 3 courses in their cognate area, and demonstrate proficiency in two other areas either through scoring above the minimum on an ACS subject exam or by completing two additional graduate level courses. Other degree requirements include a first-year conference where they present their proposed dissertation research, defense of an original research proposal, and cognate research.

Because CER requires expertise in about research methods, CER Scholars also must enroll in both a qualitative methods course and a quantitative methods course. To further prepare the Scholars for careers in CER, the PI (Stacey Lowery Bretz) developed two courses which are taught in the Department of Chemistry and Biochemistry: 1) Chemical Misconceptions & Conceptual Change and 2) Learning Theories in Chemistry Education. These courses are open to all graduate students, and several chemistry and biology graduate students have enrolled in these two courses. Weekly hour long seminars on topics related to assessment in chemistry (science) education also prepare Scholars for their future careers in CER.

The primary outcome of Scholars' dissertation work is a suite of chemistry concept inventories (CCIs), developed from analysis of student interview data. Interviews focus on students' understandings of multiple representations across Johnstone's domains of macroscopic, particulate, and symbolic content. To interview secondary students, Scholars develop partnerships with high school chemistry teachers across the country. Partner teachers validate the content on the CCIs and administer the assessments to their students. Scholars provide summative feedback to each teacher, including their students' alternative conceptions about the topic as well as descriptive statistics such as mean score, standard deviation, and frequency of responses. Too often, science education research fails to find its way into classrooms (or lecture halls), so these partnerships with high school teachers are expected to generate conversations about best practices for assessing teaching and learning that extend within the partner teachers' schools and beyond to their districts. Furthermore, greater insight into the preparation of high school students likely to enter general chemistry courses at the university level is useful data for introductory chemistry instructors.

Another component of preparing Scholars for careers in CER is the Chemistry Education Research Graduate Student Conferences, which provided mentoring experiences not only for CER Scholars but also for 80+ CER graduate students across the country. Taking place at Miami University, the first conference was held in June 2009 and the second one was held in June 2011. Airfare, lodging, and meals were provided. For most CER graduate students, the conferences were the first one they had ever attended. The two-day conference included professional development (e.g., CER faculty-led workshops on peer-review, NSF grant proposals, and applying for academic jobs), keynote speakers, poster presentations of students' research, and mentoring, which took place between graduate students themselves as well as between faculty facilitators/speakers and graduate students.

Graduate student participants completed an online survey prior to arrival at each conference and after the final keynote address. Likert-scale items from two broad categories were on the survey: occupational and organizational. These items were based on participants' affective commitments to CER (occupational) or to the CER community (organizational). Mean scores for organizational items increased from the pre-administration to the post-administration, suggesting that the conference affected students' sense of belonging to the CER community. Mean scores for occupational items increased only slightly, however. The program evaluators were participant observers during conference activities and conducted 30 minute interviews with some of the conference attendees.

In addition to evaluating the impact of the CER Graduate Student Conferences on Scholars and other CER graduate students, evaluation of the Program includes the following components: (1) development and mentoring of the Scholars, (2) investigation of the process by which Scholars construct their research identities, and (3) the quality of CCIs produced by Scholars. The Project evaluators make annual visits to Miami to interview Scholars and learn about their experiences

among the cohort of graduate students supported by the DRK-12 grant. A summative evaluation is expected at the end of the funding period.