

An Interdisciplinary Exploration of Student Engagement in Scientific Practices in Undergraduate Biology, Chemistry, and Physics Laboratory Courses

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Abstract:

Research in biology, chemistry, and physics laboratory courses demonstrates the importance of practices-based learning for course objectives and student outcomes. Specifically, this project focuses on the eight scientific practices described in the Framework for K-12 Education and embedded in the Next Generation Science Standards. In the laboratory, scientific practices are important because they are fundamental to scientific discovery, inherently interdisciplinary, and applicable across scientific contexts in higher education. Because many students enroll in introductory laboratory courses for multiple disciplines at the same time, there is a need for interdisciplinary investigation into how students experience practices in such courses. This project will investigate the differences and similarities in how the practices are incorporated and experienced in introductory laboratory courses across three disciplines: biology, chemistry, and physics. It will focus on how students, staff, faculty, and teaching assistants value practices that are perceived as more technical (such as analyzing data) or more social (such as communicating information) with the understanding that different stakeholders may value some practices differently than others. This project will determine whether and how students engage in particular practices in biology, chemistry, and physics laboratory courses and how that engagement is encouraged and rewarded. The findings from this project will expand on the current understanding of how practices are articulated and enacted in introductory science courses, thus laying a foundation for making these courses more equitable for, and supportive of, a greater diversity of learners.

The goal of this interdisciplinary project is to explore the incorporation and gendering of scientific practices in introductory biology, chemistry, and physics lab courses at a primarily undergraduate institution using a comparative case study research design. This project will blend three theoretical lenses: the Framework for K-12 Science Education, accountable disciplinary knowledge (ADK), and technical-social dualism (TDS). These three lenses operationalize what counts as a scientific practice (the Framework), what it means for students to be accountable for engaging in a practice (ADK), and the gendering of practices that are perceived to be more technical/masculine versus more social/feminine (TDS). The comparative case study approach will enable critical analyses of data from a variety of sources: surveys, interviews, and classroom observations and artifacts. Case studies of biology, chemistry, and physics lab courses will provide insight into structural and interpersonal equity with regard to how scientific practices are valued and enacted across disciplines, and by whom. Structural perspectives include which practices are targeted by departmental and instructor learning goals, as well how those practices are assessed. Interpersonal perspectives include how instructors and teaching assistants facilitate student engagement in practices, and how students participate in scientific practices. There are relatively few interdisciplinary studies across biology, chemistry, and physics at the undergraduate level, and this work will help to fill a significant gap in the discipline-based education research (DBER) literature. Further, this project will provide insight into structural and interpersonal mechanisms through which introductory laboratory courses may contribute to perceptions of some scientific disciplines as more social/feminine or technical/masculine than others. Finally, the findings from this work will lay a foundation to support faculty, staff, and other instructors in their efforts to improve their interactions, instruction, and mentorship of students in the early stages of their science careers.