Research Statement
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Physics Education Research and Contexts of Student Learning

My research interests lie within the newly developing field of physics education research (PER). In the last decade (and especially in the last few years), physics education research has undergone tremendous growth as evidenced by the acceptance of PER as a research emphasis within physics by the American Physical Society, the development of the Physics Education Research Conference, and two new journals, the *Physics Education Research Supplement* to the *American Journal of Physics* and a Special Topics version of *Physical Review*. Physicists have recognized that education research *by* physicists is necessary, because: we intend to improve the education of future physicists; the scientific approach we bring to the research questions is productive; and the questions of education in physics require a mastery of the domain itself. As a result, the current cohort of junior faculty in PER are among the first to be appointed to tenure track lines in physics departments. My efforts are directed at building and promoting this new sub-discipline of physics. My research focuses on the role of context, and in particular three levels of context critical to students' learning in physics: the student, the course, and institutional structures. For example:

Why do university students exit courses capable of solving difficult analytic problems (e.g., calculate current in a complex circuit), but are unable to explain the same content conceptually (e.g., which light bulb is brighter in such a circuit)?

While PER has developed many proven classroom reforms, their replication is not well studied. What are the necessary elements of adopting proven educational reforms?

Why do many of the educational reforms being called for today echo the calls of almost 100 years ago? What are the characteristics of sustainable and scaleable reforms?

Building on the established foundations of PER that have focused on student cognition, curriculum design and course practices, my research establishes a different perspective from which we may understand student learning in physics – one that emphasizes the central role of context in physics education. That is, how and what students learn depends not only on content as traditionally conceived, but also upon the tasks, class environments, and broader institutional structures in which the content is embedded– what I refer to as levels of context. Such a perspective begins to explain a host of research questions, like those listed above.

Because these three contextual levels of educational practice (student, course and institution) strongly influence one another, they are best studied simultaneously to discover the relations among them. To elucidate these relations, I focus on specific sets of questions surrounding common themes which span these levels of context: tools, such as the use of computer simulations; practices, such as student teaching as a mechanism of learning; and surrounding frames, such as departmental norms and their influence on student learning. Many of my research questions are new in physics (e.g., examining the effects of having students teach others in order to learn) while other questions augment existing lines of research (e.g., the role of computer simulations in the classroom). Collectively, these investigations provide a framework for understanding individual aspects of student learning and allow us to interpret their results and portability to other environments. In short, answering these coordinated questions will result in meaningful models of context and student learning in physics education.

These efforts will infuse education into broader physics practice, and simultaneously make physics more accessible in other educational realms. My efforts, which have already contributed to the establishment of a new research line in PER at the University of Colorado, will provide productive models of student learning in physics useful to both theorists and practitioners as this new domain of scientific inquiry develops.