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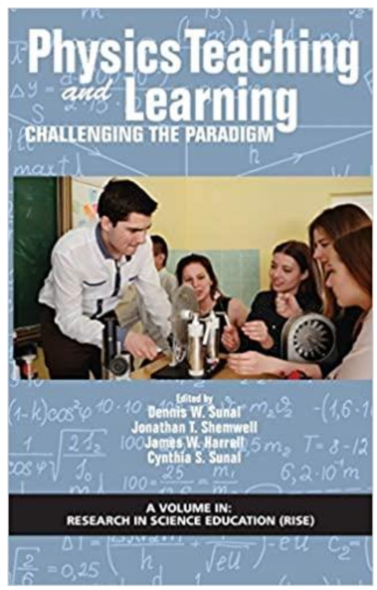

High-quality STEM (science, technology, engineering, and mathematics) education is considered an international priority for addressing global challenges (Shernoff et al., 2017; Tanenbaum et al., 2016). However, physics education has traditionally been, and remains, a particularly difficult case to handle (Banilower, 2013; Hodapp et al., 2009). The vast majority of high school physics teachers are not certified to teach the subject (Kena et al., 2015), and even fewer have a college degree in the field (Tesfaye & White, 2012), leaving most physics instructors ill-prepared to effectively teach their courses (Meltzer, 2012). Reforming physics education has been fairly high on the priority list for administrators and secondary teachers (Meltzer & Otero, 2015). Helping teachers transition from traditional lectures to more engaging pedagogies is at the core of this reformation (e.g., Liu & Sun, 2021), which has been especially important recently due to COVID-dictated remote education. Sunal et al.'s *Physics Teaching and Learning: Challenging the Paradigm* covers several strategies aimed at helping physics teachers improve their practice.

The eighth volume in the *Research in Science Education* (RISE) series; this 254-page edited collection comprises nine chapters written by 26 authors. The goal of the RISE series is to present "currently unavailable, or difficult to gather, materials from a variety of viewpoints and sources in a usable and organized format" (p. vii) for K-12 teachers. This volume is accessible and clearly organized into three major themes: improvements to teacher professional development programs, scholarship of teaching and learning (SoTL) projects, and overarching

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issues in physics education. However, readers seeking groundbreaking work or research not already freely accessible should look elsewhere.

The first section focuses on professional development programs for physics teachers, specifically the positive effects that professional development can have on enhancing teachers' pedagogical content knowledge, or the type of expertise that only educators develop which allows them to effectively relate the content to their pedagogy. The authors use the crucial aspects of professional development laid out by Desimone (2011) to guide their studies: inquiry-based content learning, active learning pedagogy, extensive and continuous hours of training, alignment of teacher training with district goals, and collaboration among in-service teachers. They find that physics professional development workshops that employ the modeling instruction approach yield significant changes in teachers' classrooms. Modeling instruction workshops are especially effective in professional development programs for physics teachers, having them shift between student role and educator role. According to the authors, this shift tends to change the way instructors perceive teaching and learning, often resulting in a student-centered pedagogy that focuses on inquiry and reflective thinking.

Moving beyond professional development and into the classroom, several contributors address tangible, in-classroom methods aimed at improving physics education. These studies could be classified as SoTL projects, although none of the authors identify them as such. SoTL "tends to be classroom-oriented, rather than theory- or hypothesis-driven… linked to what [faculty] see in the learning, or misunderstandings, of their students" (Felten, 2013, p. 121). With a narrow focus on unique practitioner issues, these chapters are well suited for that categorization.

For example, one study focuses on computational modeling of complex systems. While prominent STEM educators recommend the incorporation of computer science into physics education (Chabay & Sherwood, 2008; diSessa, 2001), it is not yet a widespread practice. This chapter emphasizes that instructors need to have a strong background in computer science in order to adequately incorporate computational modeling into their curriculum. However, the persistent notion that computational modeling is "a promising avenue for motivating talented students" (p. 130, emphasis added) can be a bit of a turnoff for those who subscribe to the growth mindset model and believe that any student can excel despite their inherent abilities (Dweck, 2006). Another chapter explores the use of personification in physics, where human characteristics are attributed to material substances. The authors of this chapter argue that the use of personification is beneficial in helping students build a bridge from metaphorical explanations to formal conceptual understanding. Another chapter that resonates with a SoTL approach presents a research-informed strategy for teaching energy to teenage students in a conceptual manner. Here, the authors concluded that their teaching sequence did increase students' conceptual understanding of energy more than traditional curriculum, but they do not claim that a conceptual approach to energy is more effective than a material approach.

Rather than speaking to broader impacts, the nature of these SoTL projects provide an acute perspective on distinct teaching practices.

The remainder of *Physics Teaching and Learning* addresses overarching issues in physics education, and this the most informative and widely applicable portion of the text. The authors tackle essential issues that plague many physics teachers, including co-construction of knowledge through scaffolding, computer-supported collaborative learning, and the limitations and pitfalls of assessment-driven teaching. If you are a K-12 public school physics teacher, you have likely run into these issues and may need some help navigating the muddy waters. From strategies of modeling the construction of knowledge to virtual simulations that promote small group work, there are some useful tips, tricks, and insights presented in these three chapters. Furthermore, these studies are extremely well-structured, with detailed explanations of frameworks, contexts, methods, and implications.

This volume provides a respectable synthesis of the literature regarding the challenges that face K-12 physics teachers as well as some suggestions for overcoming those challenges. Much of the content is valuable for those who do not have in-depth or personal knowledge of what it is like to teach physics in an assessment-driven K-12 setting. For instance, some authors include their assessment tools, including the pre-test, post-test, and interview protocols, as a resource for the reader. Indeed, several chapters in this text clearly show how physics instructors are "challenging the paradigm of teacher-centered instruction" (p. 106) in order to "align the learning experiences they [provide] to students with their knowledge about how to help students learn using more constructivist, student-centered inquiry and problem-solving approaches" (p. 169). However, some chapters contain substantial deficiencies (lack of detailed explanations of frameworks, contexts, methods, and implications), that distract from the ideas the authors were trying to convey and hinder their applicability.

Physics education reform is a multifaceted effort, and the authors who contributed to *Physics Teaching and Learning* attempt to address the issue by providing their unique and varied perspectives. The authors show educators that even though physics education needs reform, specific problems can be tackled through professional development programs, broad pedagogical choices, and individual lesson decisions. Despite some limitations, this edited collection is a step in the right direction toward building a roadmap out of the persistent predicament of low-quality physics education.

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About the Reviewer

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