

Foreword

In a report the United States President's Council of Advisors on Science and Technology (2010, p. vii) wrote, "STEM education will determine whether the United States will remain a leader among nations and whether we will be able to solve immense challenges in such areas as energy, health, environmental protection, and national security."

There is a critical need to deepen students' knowledge and interests in the fields of Science, Technology, Engineering, and Mathematics (STEM). Recent studies and federal reports cite low percentages of students interested in careers in the STEM fields (Mohr-Schroeder et al., 2014; U.S. Department of Education, 2014). This is especially true for students from low socio-economic backgrounds and from minority populations such as African-American and Latino (National Research Council, 2011).

At the same time as these calls to develop knowledge, skills, and interest in STEM fields, international studies continue to cite the United States' average performances on international assessments such as the Programme for International Student Assessment ([PISA]; OCED, 2012). The results from a recent international assessment show that the United States ranks below average in mathematics and is 27th out of the 34 nations who participated in the assessment. Researchers cite that the United States students' lack of problem solving and reasoning skills are a primary cause for these low scores (OCED, 2012).

When educational leaders, researchers, and others discuss successes and barriers to student achievement, it is necessary to examine and look at teacher quality, specifically the knowledge and skills that teachers have and that they readily apply in their classrooms (Nye, Konstantopoulos, & Hedges, 2004). In order to effectively teach STEM content effectively to students, teachers require knowledge of pedagogy, content, and how students learn. The seminal work of Pedagogical Content Knowledge from Shulman (1986) has long been held up as a construct to represent the intersection of content and pedagogy needed in order to effectively teach.

In the past decade with the arrival of the digital age, educational technologists have contributed to this conversation with the construct of Technological Pedagogical Content Knowledge (TPACK; Mishra & Koehler, 2006; Niess, 2005), which represents the intersection of knowledge of technology, pedagogy, and content. TPACK has been used as a framework to design world-class professional development experiences for teachers as well as a construct by which to examine teachers' knowledge as enacted during professional development as well as in their own classroom (Polly, 2011; Polly & Orrill, 2016). Research around TPACK is advanced by this book, as the TPACK framework is front and center as the framework used to design the online professional development program featured here. Further, through the research studies and evaluation of the professional development project, Niess and her colleagues created an empirically-based online TPACK learning trajectory that informed the implementation of their professional development project. Through the professional development effort, over the multiple research years many inservice teachers deepened their TPACK and effectively improved their mathematics and science instruction through the use of technology as a tool to support students' exploration of concepts.

The publication of this book brings to light several implications related to professional development in online settings and the TPACK framework. First, the development of an empirically-based trajectory for online professional development holds promise. In this book, that was developed for mathematics and science professional development. However, more work is needed to see if a similar or slightly different model is needed for other content areas. Since both mathematics and science are concepts in which educational leaders advocate for teaching in an exploratory, inquiry-based manner would the same model work for other content areas such as literacy or social studies? Lastly, the research presented in this book addresses the development of TPACK using a variety of methodologies and data sources. The collection of work in this book is commendable with the compilation of data from surveys, interviews, focus groups, and teachers' work samples. The field needs to continue this line of work by examining the enactment of TPACK in a myriad of ways using multiple data sources, including looking at TPACK development interplays with student achievement in specific content areas.

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