Chapter 100

Technological Pedagogical Content Knowledge:
Preparation and Support of Mathematics Teachers

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ABSTRACT

The purpose of this study was to analyze the literature regarding implementation of the Technological Pedagogical Content Knowledge (TPACK) framework in the preparation and support of mathematics teachers. A comprehensive literature review was performed on over a decade of relevant peer-reviewed publications and dissertations since the National Council of Teachers of Mathematics (NCTM) first identified technology as a fundamental principle of good mathematics programs. The results indicate that TPACK has become a foundational framework in the research. Specific studies highlighted in this paper show that, while individual components of TPACK are illustrated in the literature, the field is still lacking sufficient examples of these components acting as a "total package" (Niess, 2008). Programs that develop and support mathematics teachers need more guidance from researchers regarding the best ways to realize the vision of NCTM.

INTRODUCTION

Many leading organizations in mathematics education have highlighted the need for teachers to know how to effectively teach mathematics using technology. For over a decade, the National Council of Teachers of Mathematics (NCTM) argued that technology was a fundamental "principle" component of a high-quality mathematics program, stating, "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, 2000). The International Society for Technology in Education (ISTE) expanded this concept to include specific standards for teaching with technology, the National Education Technology Standards for Teachers (NETS-T) (2008). The Association of Mathematics Teacher Educators (AMTE) (2006) advanced the notion that instruction regarding technology integration must occur in teacher preparation programs and professional development experiences, and adopted standards specific to such mathematics teaching.

In 2011, NCTM published a technology teaching and learning position statement with the following expectation regarding knowledge of technology use among preservice and inservice mathematics teachers:

It is essential that teachers and students have regular access to technologies that support and advance mathematical sense making, reasoning, problem solving, and communication. Effective teachers optimize the potential of technology to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics. When teachers use technology strategically, they can provide greater access to mathematics for all students. (NCTM, 2011, para.1)

Time has passed since the publication of these position statements and a logical question emerges: are teacher education programs answering the calls of ISTE, AMTE, and NCTM? One potential source for answers to this question is published research. This led us to ask, does the literature provide evidence that preservice and inservice teachers are engaging in critical experiences of teaching with technology?

In the early 2000s, with the increasing emergence of and access to digital technologies, some looked to define the knowledge teachers needed to effectively incorporate technologies into their practice as teaching and learning tools (Pierson, 2001). Researchers promoted a new vision of the knowledge that teachers needed for integrating technology, pedagogy, and content; those ideas were illustrated in the Technological Pedagogical Content Knowledge (TPACK) framework (Margerum-Leys & Marx, 2002; Mishra & Koehler, 2006; Niess, 2005; Thompson & Mishra, 2007; Zhao, 2003). This new framework was intended to guide the redesign of teacher preparation programs to focus on supporting new ways of thinking about teaching content with appropriate technologies. To guide teacher educators in understanding the TPACK framework, Niess (2005) described four components based on the work of Grossman (1990). Using mathematics as the content, the TPACK components were described as:

1. An overarching conception of what it means to teach a particular subject such as mathematics integrating technology in the learning;
2. Knowledge of instructional strategies and representations for teaching particular mathematical topics with technology;
3. Knowledge of students' understanding, thinking, and learning with technology in a subject such as mathematics; and
4. Knowledge of curriculum and curriculum materials that integrates technology with learning mathematics (Niess, 2005).

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