

Chapter 17

Transforming Mathematics Teacher Knowledge in the Digital Age Through Iterative Design of Course-Based Projects

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ABSTRACT

This research in this chapter highlights a self-study of three university faculty members who were aimed at improving the design of an Elementary Mathematics Technology Integration Course (EMTIC). The self-study used the faculty unique research lenses and expertise in mathematics education and educational technology to redesign the performance based assignments to better prepare the teacher candidates to integrate technology into their mathematics teaching. This collaboration required faculty members to: 1) Reflect on their beliefs about technology integration; 2) Evaluate their current teaching practices; and 3) Adapt the design of their course assignments to better meet the skills required of teachers and students in the 21st century.

INTRODUCTION

The Technology Principle from the Principles and Standards for School Mathematics (NCTM, 2000) states that “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning.” Digital technologies have the potential with its visual and dynamic displays to offer a broader interpretation of mathematical representations. Hoadley and

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Kirby (2004) noted that incorporating representations through the use of technology provide the “unprecedented ability to create, manipulate and share representations of [a] wide variety” (p. 2). The decisions teacher candidates make with regards to implementing technology in their mathematics classroom, whether an enhancement or a hindrance to student learning, depends on the knowledge gained during a teacher preparation program (Lee & Hollenbrands, 2008). In order to enable their future students to understand mathematical concepts, teacher candidates need to capitalize on the power of technology to create meaningful lessons during their teacher preparation programs. Providing an instructional framework that enables solving mathematical tasks using technology, and to reflect on their experiences can assist teacher candidates to develop an understanding of how technology can be integrated into math instruction (Lee & Hollenbrands).

Extending from Shulman’s original framework of pedagogical content knowledge (Shulman, 1986, 1987), the framework of Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2009; Mishra & Koehler, 2006) moved educators to consider the connections, interactions, affordances, and constraints between and among technology, pedagogy, and content. In this model, knowledge about technology (T), pedagogy (P), and content (C) is central for developing good teaching.

What is important within this framework is not only the separate components, but also the interaction between and among these three components (Koehler & Mishra; Niess, 2005, 2008). Teachers need to possess technological knowledge (how to use the technology), pedagogical knowledge (how to teach students) and content knowledge (what to teach). Additionally, to effectively integrate technology teachers also need to develop technological content knowledge (the alignment of the content with the appropriate technology) and technological pedagogical knowledge (the alignment of the content with the appropriate technology to instruct students). (Sprague & Katradis, in press)

With regards to mathematics education, the C in TPACK represents mathematics; specifically the content strands such as algebra, numbers and operations, and geometry.

Soon after TPACK was introduced, the Association of Mathematics Teacher Educators (AMTE, 2009) released a statement about Mathematics TPACK stating that mathematics educators have an important role in serving their teacher candidates by planning and modeling 21st century digital tools. The framework that was shared with mathematics educators not only elaborated on the TPACK Model and the International Society for Technology in Education (ISTE) Standards for Teachers (ISTE, 2008), but was also designed to inform mathematics teachers, university educators, professional development facilitators and researchers “to plan, examine, improve, and evaluate mathematics instruction at all levels” (AMTE, p. 1). The framework delineated four essential components for enhancing teachers’ mathematical learning experiences via technology:

1. Design and develop technology-enhanced math learning environments and experiences;
2. Facilitate mathematics instruction with technology as an integrated tool;
3. Assess and evaluate technology enriched mathematics teaching and learning; and
4. Engage in ongoing professional development to enhance their TPACK (AMTE).

In addition to the current research and dialogue centered on TPACK, the mathematics community also has stressed an importance for mathematics educators to implement high-leverage and core teaching practices (Ball & Forzani, 2010). These ongoing discussions prompted us as researchers to consider not

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