Chapter 1
The Impact of Digital Technologies in Mathematics Pre-Service Teacher Preparation over Four Decades

Sarah B. Bush
Bellarmine University, USA

Shannon O. Driskell
University of Dayton, USA

Margaret L. Niess
Oregon State University, USA

David Pugalee
University of North Carolina – Charlotte, USA

Christopher R. Rakes
University of Maryland – Baltimore County, USA

Robert N. Ronau
University of Cincinnati, USA

ABSTRACT

The rapid expansion of technology integration in everyday lives calls for a rethinking of teaching and learning with current and emerging digital technologies. How have pre-service teachers been prepared for teaching with these new technologies? Are they prepared for this educational revolution? This chapter presents an analysis of the impact of digital technologies in mathematics pre-service teacher preparation over the past four decades. The chapter examines how various technology types, content strands, grade-level bands, teacher outcomes, conceptual frameworks, research questions, and alignment with the Common Core State Standards for Mathematics (CCSSM) (CCSSO, 2010) Mathematical Practices (CCSSM-MP) have influenced the outcomes from mathematics teacher education papers and how this literature has affected teacher preparation. The goal of this examination is to identify recommendations for future mathematics teacher preparation research that show promise for revising mathematics teacher preparation in this digital age.

DOI: 10.4018/978-1-4666-8403-4.ch001

INTRODUCTION

What it means to teach mathematics has changed over the past four decades. By the close of the 1960s, the "New Math" curriculum gave way to a "Back to Basics" curriculum. In the 1970s the idea of "math labs" gained momentum for engaging elementary students in hands-on explorations with manipulative materials. The 1980s marked a shift of the curriculum to a problem solving focus. This emphasis raised issues as to whether paper-pencil calculations distracted thinking in problem solving and called for students to have access to appropriate tools for computations. Calculators and computers became available, but at what cost? By the 1990s, the "math wars" were in full force as a reaction to increased access to calculators and computers. By 2000, the National Council of Teachers of Mathematics (NCTM) released its Technology Principle in *Principles and Standards for School Mathematics* claiming that: "The existence, versatility, and power of technology make it possible and necessary to reexamine what mathematics students should learn as well as how they can best learn it" (p. 25). And, since that time, the impact of digital technologies has challenged the understanding of what it means to teach mathematics. Currently, the mobile revolution presents challenges for mathematics education to take advantage of a new wave of electronic devices offering new ways for learning mathematics. Resistance to calculator use persists despite the overwhelming research indicating that using calculators appropriately helps students learn and does no harm to basic skills (Ronau et al., 2011). Today, many digital textbooks are available for a wide array of platforms along with multiple applications for engaging students in exploration. This digital world has invaded the mathematics teaching world. This digital world has transformed the capabilities of the tools available to mathematics teachers. Are mathematics teachers prepared to enhance their instruction with technology? Has pre-service teacher preparation kept pace with technology changes over the past four decades?

Professional organizations have acknowledged and advocated the need for pre-service teacher preparation to address effective teaching with technology. The International Society for Technology in Education (ISTE) released the 1998 National Educational Technology Standards for Students (NETS•S), which called for the effective use of technology in education. Soon thereafter, ISTE recognized that these new standards called for different types of teacher knowledge, and released the 2000 NETS Teacher Standards (NETS•T). In 2007 and 2008, ISTE shifted its focus in these standards from operating technology to effectively using technology to enhance teaching and learning.

Likewise, NCTM included the effective use of technology to enhance mathematics teaching and learning in its *Principles and Standards for School Mathematics* (2000). In its 2011 position statement, NCTM stated,

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. (para. 1)

Similarly, the Association of Mathematics Teacher Educators (AMTE) advocated for enhancing the preparation of mathematics teachers in their Technology Position Statement: "Mathematics teacher preparation programs must ensure that all mathematics teachers and teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology in the context of teaching and learning mathematics" (AMTE, 2006). The application of research to