Preface

THE POTENTIAL OF TECHNOLOGY IN MATHEMATICS CLASSROOMS

Money continues to get poured into the purchase of educational technologies (New Media Consortium, 2013). In the past few decades, classrooms from pre-Kindergarten through university levels have seen the arrival of numerous types of educational technologies from desktop computers with software to the latest mobile, hand-held devices. Naturally, with any large investment of resources into educational ideas, there is always the looming question about the potential impact of these initiatives and reforms. While the empirical impact of using technology in the teaching and learning processes of mathematics is not crystal clear, there have been studies and examples that when used appropriately, technology has the potential to positively benefit both teachers and students in all grade levels.

In most of my own research and work, I frequently revisit and draw on the findings from Wenglinsky (1998) when he conducted a large-scale study with the Educational Testing Service related to students’ technology use in mathematics and their achievement. While this study is 15 years old now, his findings were significant and still align to the directions of mathematics educators in the world, especially in the United States. Using data from the 1996 National Assessment of Educational Progress (NAEP), Wenglinsky found that eighth-grade students who had used technology to work on higher-order math skills, such as problem solving, scored approximately one-third of a grade level higher than students who had used technology for lower-order skills or had not used technology at all. For eighth-graders when computers were used to teach lower-order or basic math skills, such as computation, student achievement was lower than students who had not used technology at all.

Leaders in mathematics education continue to call for the use of developing students’ higher-level skills through the use of cognitively demanding mathematical tasks in classrooms of all grade levels (e.g., Boston & Smith, 2009; NCTM, 2000; Polly & Hannafin, 2011; Smith, Stein, & Remillard, 2007). The creation and large-scale adoption of the Common Core State Standards for Mathematics (CCSSI,
2011) provided a great deal of leverage with the eight Standards for Mathematical Practices (SMP), especially SMP 5, “Use appropriate tools strategically,” and SMP 1, “Make sense of problems and persevere while solving them.” With the adoption of the CCSS-M and the recommendations of mathematics educators, teachers from Kindergarten through Grade 12 are now expected to support their students’ learning by posing cognitively demanding mathematical tasks and support students’ exploration of these tasks by providing opportunities to use various manipulatives and other mathematical tools.

While these ideas make sense and have been supported in various projects, there is a lengthy trail of research citing teachers’ struggles teaching mathematics in this way and using technology in ways that extend beyond lower-level skills activities (Cognition and Technology Group at Vanderbilt, 1997; Henningsen & Stein, 1997; Polly & Hannafin, 2011; Smith, et al., 2007). There is still a need to examine and ways to effectively support large numbers of teachers in their implementation of cognitively demanding mathematical tasks as well as using technology to effectively support that work (Polly & Orrill, 2012). The purpose of this edited book is to provide some cases and examples that move us in the direction of continuing to support the important work of teachers.

OVERVIEW OF CHAPTERS

This edited volume is a collection of vignettes, stories, and examples of how technology can support and enhance the teaching and learning of mathematics education. As we continue to support teachers’ work with posing cognitively demanding mathematical tasks and using technology effectively, it helps to draw on examples of others as opportunities to learn.

For this project, I have kept the term mathematics education intentionally broad to encompass concepts related to the teaching and learning of mathematics from pre-Kindergarten through college. The purpose in doing that was to assemble a collection of chapters that ranges in diversity and represents the heterogenous ways in which technology so powerfully supports mathematics teaching and learning.

The book has been organized into four primary sections: “Leveraging Technology to Teach Specific Content,” “Leveraging Technology to Support Mathematical Practices,” “Examples of Technological Tools to Support Teaching and Learning,” and “Leveraging Technology to Support Mathematics Education Courses and Programs.” While these four sections have helped to organize the different chapters of this book, it is intuitive and must be explicitly stated that these areas—content, practices, tools, and course or program curriculum—cannot be held in isolation. Moreover, it is the intersection of these concepts and aspects that make the use of
technology in mathematics classrooms so much more powerful for both teachers and learners.

In the first section, “Leveraging Technology to Teach Specific Content,” Niess opens with her case about how spreadsheets can be integrated into middle grades and secondary classrooms to support learners’ algebraic thinking and reasoning. In Chapter 2, Kleanthous and Meletiou-Mavrotheris describe how they have used statistics software with primary grades students in Cyprus to promote their understanding of data and statistical literacy. In Chapter 3, Lim, Deahl, Rubel, and Williams describe how they used a curriculum about the lottery as a real-world context and mobile technologies for secondary students to study statistics. Chapter 4 features Wasserman’s explanation about how SketchUp can be brought into mathematics education courses to explore the properties of three-dimensional figures. Chapter 5 focuses on Lapp’s and St. John’s description of how a secondary teacher used technology and reform-based pedagogies to support her students’ exploration of perpendicular lines in a high school algebra course. The section closes with Polly, Hill, and Vuljanic’s co-teaching explorations, in which they used technology to support first and second grade students’ composition and decomposition of two-dimensional shapes.

Section 2, “Leveraging Technology to Support Mathematical Practices,” opens with Chapter 7, a description from Pritchard, O’Hara, and Zwiers about how current technologies can support and motivate English Language Learners in mathematics classrooms. In Chapter 8, Hodges, Hipchen, and Newton describe a lesson done in fifth grade in which students visited a local power plant and used technologies to explore and model mathematics in a real-life context. The next chapter includes Lassak’s ideas about how technology can be utilized to support teachers’ Common Core Standards for Mathematical Practices. In Chapter 10, Browning and Smith describe a case in which technology-supported pre-service teachers’ statistical inquiry and their understanding of the Common Core Standards for Mathematical Practice. The section closes with Chapter 11 where Sherman, McCaffrey, Hillen, and Cayton’s provide examples about how geometry software can support high school students’ understanding of geometry concepts and the Common Core Standards for Mathematical Practice.

Section 3 focuses on “Examples of Technological Tools to Support Teaching and Learning.” In Chapter 12, Trespalacios, Trujillo, and Uribe-Flórez describe how they used multimedia animations to support students’ learning of various concepts including ratio and proportions. Next, Wall and Rogers discuss their process of analyzing and developing iPad applications to support elementary students’ mathematics learning. In Chapter 14, Goodson-Espy provides an overview of the use of interactive white boards in elementary school mathematics classrooms. In Chapter 15, Gadanidis provides a description of how coding can be used with elementary school students to support their understanding of mathematical modeling. Next,
Polly, Little, Rodgers, and Messick describe how handheld interactive clickers have supported mathematics teaching in fourth grade classrooms. In Chapter 17, Salinas and Ly share a case about how games and teachers’ pedagogies can support early childhood mathematics development. Finally, Martin and Polly close the section with their description of a Web-based formative assessment tool used in Kindergarten classrooms.

Section 4, “Leveraging Technology to Support Mathematics Education Courses and Programs,” focuses on how technology has supported university courses and programs. In Chapter 19, Hall, Bush, and Lacefield describe how they have incorporated Web 2.0 technologies into mathematics education courses. Next, Kurz, Bartholomew, Sibley, and Fraser describe how they had pre-service teachers create stories in PowerPoint to develop elementary students’ algebraic reasoning. In Chapter 21, Rambally describes how the concepts of computational thinking and mathematical thinking have been incorporated into his university courses. Lastly, in Chapter 22, Cai provides examples of how he has used technology to support his college students’ mathematics knowledge as a prerequisite for engineering coursework.

In summary, this book provides a collection of cases and examples on how technology can support the teaching and learning of mathematics. The cases include examples from elementary, middle, secondary, and university levels. Hopefully, you will find these cases insightful and apply some of these ideas and principles in your own work.

Drew Polly
University of North Carolina at Charlotte, USA

REFERENCES


