BOOK REVIEW

Cases on Technology Integration in Mathematics Education

Reviewed By Mark P. Ryan, Loyola Marymount University, Department of Education, Los Angeles, CA, USA

Cases on Technology Integration in Mathematics Education (Advances in Educational Technologies and Instructional Design)
Drew Polly
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INTRODUCTION

'Cases on Technology Integration in Mathematics Education' provides various examples of how technology can effectively be integrated into the teaching and learning process for K-12 classrooms. As America's education system transitions to the Common Core, such integration is not only necessary, but as this book proves, such integration actually makes a positive impact on student understanding of complex mathematical ideas, allows students to model mathematical thinking, and shows how technology can be used as the powerful tool it was intended to be in the Common Core State Standards.

ORGANIZATION OF THE BOOK

The book does an excellent job of providing meaningful real world examples of how to use technology as a teaching and learning tool for the Common Core State Standards for Mathematics (CCSS-M) in classrooms of all grade levels. The examples provide the reader with practical ideas of how technology can be integrated by teachers and students in ways that are not just "add ons" or after thoughts. Rather, the examples demonstrate how technology can and should be used as a tool for both instructor and student to make learning fun, straightforward, and powerful.

One of the most important points made by the authors is that technology is not simply something to be tacked on to a lesson plan after the base plan has been completed. Rather, the power of technology needs to be at the forefront of the instructional planning cycle. Technology has the power to make abstract ideas concrete, to make complex mathematical equations applicable to real world situations, and to take voluminous data and synthesize those data into manageable chunks. What would have

taken hours or longer in "the old days" of math instruction can now take seconds, giving the teacher and students more time to grapple with deeper mathematical thinking. Technology can be a powerful tool for students to demonstrate their mathematical reasoning, and this book provides various solid examples of that process.

In "Leveraging Dynamic and Dependable Spreadsheets Focusing on Algebraic Thinking and Reasoning", Margaret Niess explains how dynamic spreadsheets (spreadsheets which can be manipulated to change variables to see patterns) can be used in middle grade classrooms to develop algebraic thinking. Such spreadsheets have great power to make complex data sets comprehensible. Niess provides a set of problems where students use spreadsheets to discover patterns in data sets. Because the spreadsheets do the arithmetic, the student manipulating the variables can more easily see patterns and develop linear equations without being bogged down in arithmetic which might result in simple errors that prevent deep understanding of the patterns. The examples Niess provides include exploring areas of rectangles with the same perimeter, creating algebraic formulas to come up with target numbers, seeing patterns and algebraic equations when building "poppy pens" (storage units for poppy flowers,) a "race" problem involving the typical "rate times time equals distance" formula in which students find answers to complex questions using vivid mathematical models, and probabilities of certain colors of M and Ms.

"A Case Study of Primary Schools Students' Use of a Dynamic Statistics Software Package for analyzing and Interpreting Data" by Irene Kleanthous and Maria Meletiou-Mavrotheris discusses the use of "InspireData" as a tool for primary grade students to collect, input, and analyze data to predict the probability of compound events occurring. The case study found that students' level of motivation was high with the use of the software package, and that students were able to "represent data in different types of plots in order to find the best way to represent meaning and to develop data-based conclusions."

The local lottery was the topic of a case study of high-school students who completed a 14-lesson unit fully aligned with the CCSS-M standards, as described in "Local Lotto: Mathematics and Mobile Technology to Study the Lottery" by Vivian Lim, Erica Deahl, Laurie Rubel and Sarah Williams. Of particular note was the cross curricular implications of this unit of study, which required students to explore community member perceptions about the local lottery and collect/present those perceptions using mobile technologies. Students used a variety of language arts skills to convey their findings, and mapped and analyzed data specific to their communities. Perhaps one of the most important findings of this chapter was that students perceived most learning to occur during the discovery phase rather than the instruction phase of the model, which brings us back to the age-old challenges of time vs. depth to master the standards.

Nicholas Wasserman from Teachers college at Columbia University provides multiple examples of how SketchUp can be used in K-12 classrooms to develop spatial reasoning and understanding of three-dimensional objects, in the chapter "Bringing Dynamic Geometry to Three Dimensions: The Use of SketchUp in Mathematics Education." A variety of CCSS-M standards can be fostered through these technological tools, including transformations, surface area and volume of three-dimensional solids, proportionality, and modeling. An interesting conclusion the author draws is that the software's design for commercial uses and not for educational purposes creates challenging scenarios for classroom teachers.

In "Playing with Perpendicular Lines: The Case of Laura," Douglas Lapp and Dennis St. John use Japanese Lesson Study to interact with the reader by providing a series of thought-provoking questions for analysis of a beginning teacher's lesson on finding the slope of perpendicular lines. Nine very intriguing questions are posited by the authors to engage the reader as though they were participating in lesson study with Laura.

"Students' Experiences Composing and Decomposing Two-Dimensional Shapes in First and Second Grade Mathematics Classrooms" is the topic of a chapter by Drew Polly, Trisha Hill, and Tabitha Wuljanic. Since CCSS-M expects the youngest learners to accomplish this and be successful at articulating their actions using age-appropriate vocabulary, the case study examined the impact of hands-on activities to construct and deconstruct shapes using shape puzzles. The case revealed significant learning between pre- and post-testing but also revealed a need for teachers to thoughtfully correct student misconceptions by starting with low-level questions about a mathematical process followed up with deeper delves into student thinking.

Mathematical understanding of English learners is the topic of three classroom vignettes in "Using New Technologies to Engage and Support English Language Learners in Mathematics Classrooms" by Robert Pritchard, Susan O'Hara and Jeff Zwiers. In the first, students created a multi-modal web page to explain math vocabulary and processes to classmates. In the second, primary EL students used Toontastic, an iPad app, to create addition or subtraction stories. In the third, students worked with partners to create Voicethread products that explained which mathematical method they used to solve a problem, why and how.

In "The Port Lesson" by Charles B. Hodges, Edie R. Hipchen and Traci Newton, two teachers and a university researcher report on a fifth grade CCSS-M lesson that required students to role play officials at various American ports who were attempting to convince a car manufacturer to do business with the port for car transit. The case study showed how the lesson was effective yet could be expanded to include additional CCSS-M standards and more impactful uses of technology.

In "What Does Technology Bring to the Common Core Mathematical Practices?" Marshall Lassak provides an overview of a variety of uses of technology to support teaching and learning of the Common Core standards in mathematics. The author advocates for technology use being "a natural event" in math classrooms, but cautions against technologies which are unfaithful to mathematical principles. There is strong evidence to suggest that students must be able to analyze whether a technological representation of a mathematical concept is accurate and the overreliance on technology risks an automatic acceptance of a tech tool's answer as the valid one.

In "Utilizing Technology to Engage in Statistical Inquiry in Light of the Standards for Mathematical Practice." Christine Browning and Dustin Owen Smith provide vignettes using tools such as TinkerPlots, Dropbox, Google Drive, and Interactive White Boards that showcase ways to use technology as a teaching and learning tool. The focus is on using technology to develop the Standards for Mathematical Practice, rather than simply allowing technology to make the user's life easier.

A case study of a catholic school geometry teacher provides another lesson study example in "Using Dynamic Geometry Software to Engage Students in the Standards for Mathematical Practice: The Case of Ms. Lowe" by Milan Sherman, Carolyn McCaffrey James, Amy Hillen and Charity Cayton. Detailed self-analysis is presented in which the teacher analyzes how GeoGebra was and was not effective as a teaching and learning tool, specifically to promote higher order mathematical thinking. Particularly useful in this case is the teacher's voice at both narrating the lesson activities and analyzing the lesson after the fact.

In "Integrating Multimedia Animations to Support Common Core State Standards in Mathematics Classrooms," Jesus Trespalacios, Karen Trujillo,and Lida Uribe-Florez present analyses of New Mexico State University's Math Snacks animations and video games which attempt to make complex mathematical ideas about ratio and proportion comprehensible. The real world animations come with lesson plans, teacher prompts, discussion questions, and assessments, all of which focus on the students' capacity to explain their mathematical thinking and understanding. The study analyzes the construction of knowledge in authentic contexts

along with extent to which students engage in meaningful reflection.

"Teaching Fundamental Math Concepts: There's an App for That…Or is There?" by Jennifer Wall and Michael P. Rogers laments the dearth of available effective mobile Apps to teach elementary math concepts and lays out guidelines for effective Apps, including clear learning goals, structure, guidance where needed, and well-defined parameters.

Interactive whiteboards (IWBs) are the topic of the next chapter by Tracy Goodson-Espy and Lisa Poling, specifically barriers to teaching and learning success and effective methodologies in the secondary math classroom. An excellent review of the literature on IWBs is followed by two case studies of effective IWB use in the university classroom, one at the University of Virginia, USA and the other at the University of Newscastle, Australia, both of which employ constructivist methodologies in lesson planning, classroom management, and assessment.

The worldwide push to get young children "coding" is the topic of George Gadanidis' chapter on "Young Children, Mathematics, and Coding: A Low Floor, High Ceiling, Wide Walls Environment." His premise is that we need to think big, and not allow our adult preconceptions about how difficult certain tasks may be to limit the learning experiences we provide to young children. Instead, we need to allow them to tackle big problems such as linear functions in the primary grades using what Gadanidis refers to as "a low floor, high ceiling, wide walls" approach to teaching mathematics.

Interactive clickers are next explored as a formative assessment tool in elementary classrooms, in "Leveraging Interactive Clickers as a Tool for Formative Assessment" by Drew Polly, Elizabeth Rodgers and Melissa Little. Two different fourth grade classroom scenarios were examples from a "learner-centered" approach, and both teacher and learner perspectives were discussed.

An experienced kindergarten teacher was the focus of research by Salinas and Ly from Boston University, who first provide an extensive review of the literature on using technology in primary classrooms in their chapter "Mathematics Gaming in Early Childhood: Describing Teacher Moves for Effective and Appropriate Implementation." Concrete examples show how video games and IWBs increase student motivation and engagement with mathematics.

The "Assessing Mathematics Concepts Anywhere" web-based assessment tool is the topic of the next chapter, by Christie Sullivan Martin and Drew Polly, which explores how teachers could and should use data from that particular assessment system to identify student misconceptions and the extent of student understanding of numbers at the primary grade level.

Mercer University's Jeffrey Hall, Lucy Bush, and William Lacefield present a variety of Web 2.0 tools developed by secondary preservice and in-service mathematics teachers in "Teaching and Learning the Common Core State Standards in Mathematics with Web 2.0 Tools." Specifically, GeoGebra, Socrative, Quizlet, and Mathcaching are explained and evaluated as resources to teach the CCSS-M standards.

Pre-service math teachers' creation of stories using digital cameras and PowerPoint is the topic of Chapter 20 of the text, "Contextualizing Algebraic Word Problems through Story Using Technology" by Terri L. Kurz, Barbara Bartholomew, Amanda Sibley and Scott Fraser. The effective integration of language arts, technology, and math is explored as a tool to reinforce essential algebra concepts.

Gerard Rambally tackles "The Synergism of Mathematical Thinking and Computational Thinking," specifically how these two sometimes divergent concepts can and should find a point of intersection. The complementarity of these forms of thinking is explored from the epistemological framework of APOS (Actions, Processes, and Objects, organized into Schemas).

The final chapter of this text explores the need to inculcate Information and Communication Technologies (ICTs) into the mathematics learning experiences of future engineers. In "Application of Information and Communication Technology to Create E-Learning Environ-

ments for Mathematics Knowledge Learning to Prepare for Engineering Education" by Tianxing Cai, Artificial Neural Networks, the Fuzzy Logic System, Genetic Algorithms, Ant Colony Optimization, Particle Swarm Optimization, the Artificial Immune System, and the Culture Algorithm are all explained as potential intersections of technology and engineering education. An example is provided of studying climate change using a variety of mathematical tools and models.

SUMMARY

I highly recommend this text to K-12 math educators and math education faculty at the university level. It provides thoughtful chapters that challenge the reader to consider how technology is being used in powerful ways to support achievement of the CCSS-M standards. This book should be required reading of all math education majors preparing for math credentials/teaching certifications.

Mark P. Ryan is currently the Superintendent of the North Valley Military Institute, a grades 6-12 public charter school in Los Angeles, CA. He is an adjunct faculty member at Loyola Marymount University and has more than two decades of experience as a math and science teachers at the middle school and high school levels.