Foreword

Touch-enabled and mobile devices in mathematics education. Why is this such an interesting topic, and what do we expect to get out of such a book?

Before we dig into the actual chapters, let’s step back and think about this phenomenon—highly portable, high-potential technology in the hands of a rapidly growing number of students around the world. We’ll start with some historical context. Then we’ll focus on the “high-potential” part: the wonders that can come from these innovations. And then we’ll temper our enthusiasm—and talk about what could possibly go wrong.

Historical Perspective

Let’s begin with the electronic “pocket” calculator, paying special attention to the pace of innovation.

In 1967, Texas Instruments created an early hand-held calculator. It weighed over a kilogram and could perform basic arithmetic on numbers up to six digits long. It even printed results on a tiny strip of paper—up to twelve digits at a time (presumably a product of two six-digit numbers). It was an interesting innovation, but it didn’t change common practice; five years later, science and mathematics students and practitioners were still using slide rules for portable calculation.

But in that year, 1972, Hewlett-Packard introduced the first commercial “scientific” calculator, the HP-35, which featured scientific notation and now-familiar keys for trigonometric and transcendental functions in addition to the “enter” key (and no “equals” key), characteristic of its insistence on reverse Polish notation.

By 1975—only three years after its introduction—when the HP-35 ended its commercial life, new electronic calculators were driving the slide rule to extinction. In 1976, Keuffel & Esser produced its last slide rule.

In less than ten years handheld electronic calculators went from non-existence to ubiquity, and eliminated a beloved and iconic tool. (And forty years later, schools are still debating whether it’s a good idea to let students use them.)

Fast-forward to 2007 and the introduction of the iPhone. Of course there had been PDAs and other handheld “smart” devices (e.g., the Newton in 1992; the Blackberry in 1999), but one can make a good case that the iPhone fundamentally changed public access to handheld computing. With the iPad in 2010, the clamor for mobile computing in schools grew even louder.

And now we sit in 2015, really just the morning after those products came on the market. And they’re everywhere. The scientific calculator replaced the slide rule: an iconic tool, sure, but really, how many people used one every day? But smart phones and tablets? In mid-2014, Apple sold it 500 millionth
iPhone; school districts in the US are buying iPads by the truckload; ChromeBooks and various Android-based tablets are in the hands of millions of students worldwide.

That’s a lot of computing power, accessible to lots of people. And it’s only just begun.

**What Can We Do with All This Mobile Power?**

This book is filled with specific ideas. But any specific ideas we have now will be obsolete in a few years. The point, therefore, is not that you should take any of these ideas and products and make a career out of them, but rather to think about what happens next. Use these ideas as springboards for your own innovation.

You should also look beneath the specific ideas and try to uncover general principles. Here are some things to think about:

- These are mobile devices. What does that imply or require? For example, the devices might need Wi-Fi to connect to the Internet. What becomes possible when students aren’t tied to a particular workstation, or even a laptop—when they can move around the classroom, or around the town, to accomplish math tasks?
- Mobile interfaces are usually touch-sensitive. This creates possibilities that don’t exist in the point-and-click paradigm of earlier computers. An interaction can seem more tactile, letting students manipulate objects in the virtual world—sometimes just as they would in the real world, and sometimes in ways that are impossible without the technology.
- Mobile devices often take advantage of a network such as the Internet. This might require Wi-Fi—which then has to work. If the devices are networked, we can update and customize the content we deliver. And it can work both ways: students can deliver responses to the content—and new content of their own.
- With networkable devices, students need not always work alone. What are the networked, community, or social aspects of mobile devices for learning math? What technology can help us create a community of learners, spread out over time or space? Also: in the current tech universe, everything seems to get rated, and rises or falls as a result of some measure of popularity. What meaning or purpose can that have in math education?
- Which brings us to the teacher. What sorts of mobile applications can we imagine for math teachers? How far beyond the “gradebook” program can we go? What tools will help facilitate the kind of teaching we would like to see and do? Dashboard applications showing where students are in their progress should be only the beginning; and content providers are scrambling to facilitate meaningful, plausible personalized instruction.
- What becomes possible when every student has, essentially, a video studio in their hands? Any student can take still pictures, video, and audio, and edit them to suit their purposes. I have seen groups in a physics class make brief, primitive vodcasts in lieu of the traditional lab reports. They addressed many more issues, and at greater sophistication, than they would if they had been constrained to pen and ink.
- Mobile devices are multitools. Cameras and microphones are only the beginning. Many of us also use our phones as scanners, geolocators, pedometers, compasses, or even flashlights. When students have all these tools in one portable box, what else can they do that we haven’t thought of?
• We also use our phones as, well, phones. Networked devices have become communications powerhouses, and we have learned the power of videoconferencing, shared screens, and more, for connecting people who are not physically together. What happens when we can easily leave the math classroom and travel to a job site, a distant university, or another classroom across town?

**What Can (and Will) Go Wrong**

The readers of this book are probably mostly forward-thinking mathematics educators, looking for ways to make the student the center of learning. We see technology as a force for student freedom and power; for innovation; for access to tools, data, and ideas.

We are in the minority.

Not that anyone will come out against freedom. But if we’re realistic about adoption of mobile devices in mathematics education, we’ll notice some forces and trends that mitigate against what we’d like to see happen.

For example: the promise of technology is often linked to personalized, differentiated instruction. Engaging curriculum on a tablet, and a responsive, intelligent management system frees up the human instructor to give students more one-on-one attention. That’s a powerful and attractive idea. But it requires huge investments in curriculum development and testing, and in professional development for teachers in how to use good electronic materials. And then more testing. It’s a difficult path. The easy and less-expensive path, unfortunately, is to replace as much human instruction as possible with poorly-designed and largely untested instructional modules that some administrator thinks are “good enough.”

This is already happening. As I write this, at the end of 2014, if you walk into a randomly selected math class in an American city, Chromebooks or iPads will not always be accessible, or even nearby. I suspect that’s the case elsewhere in the world as well. If students are using tablets, you will often find them using inexpensive, not particularly imaginative software: math learning “systems” that lead students through what we might call a corporate interpretation of mathematics content. You will even see electronic versions of paper textbooks, thinly enhanced with a few “interactives”—movies or applets demonstrating some concept.

The other likely and depressing use is for testing. In the United States, assessment is a big driver of technology purchases. In order to facilitate scoring, many high-stakes tests are now delivered at least partially online. As a result, many students’ primary use of technology is to prepare for and take tests.

**Why You Shouldn’t Be Depressed after All That**

We should not be surprised by any of this.

We have been working (some of us for decades) with the most forward-looking teachers, in schools with visionary administrators. We spend months or years with a group of students, fine-tuning our approach, often to give the students the best, most exploratory, most student-centered experience imaginable, and one that uses the technology to the limits of its capabilities.

But these are often small groups. Their students are the happy few, the luckiest learners in the world. To get millions of students to use the tools, though, requires big business. Someone has to stand to make a lot of money.

And right now, in the United States at least, that means testing. And wide-scale online testing, like online curriculum, is currently primitive. The promise of tactile, dynamic, interactive assessment items is
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currently drowning under the need to produce banks of items that work on millions of devices, far from their developers. So for now we have a lot of multiple choice, and a few marginally-more-flexible item types, simply because it’s too hard to make the special-purpose software that would be more interesting.

That’s today’s situation. But these dark clouds will change as fast as the technology does—and the seeds of that change are right here. Every chapter in this book represents a new possibility, a proof-of-concept, a step towards a more student-centered, flexible, powerful vision of mobile mathematics education. With time and persistence, these ideas and those that follow will infect the emerging practice, in ways we can’t foresee.

Remember: ten years ago there was no iPhone.

Tim Erickson  
EEPS Media, USA

Tim Erickson has been involved in statistics and technology education for many years. He has worked with educational centers such as the Lawrence Hall of Science and the Exploratorium; with publishers such as Key Curriculum Press and WH Freeman; with foundations such as Annenberg and CIENTEC (in Costa Rica); and with universities, schools, and districts all over the USA. He is the author of several books for statistics, math, and science teachers, including Data in Depth, Fifty Fathoms, Get It Together, and A Den of Inquiry; he is also one of the principal designers of Fathom dynamic data software, and has been awarded four Small Business Innovation grants from the National Science Foundation.