

Elementary pre-service mathematics teachers and technology: are they ready?

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Abstract

Using technology is a necessity in the elementary mathematics classroom in today's schools. Mathematics educators must guide their students to use the proper tools before they graduate and become teachers. In this paper, the researchers will share their knowledge of how little senior level, pre-service mathematics teachers know about technology resources. Data involving the change in students' opinions as to what is available to them will be included. The researchers will share the resources available to students that they believe should be introduced early in the teacher education program for pre-service teachers to have ample opportunity to take advantage of them and integrate these resources into their field experiences, including practicum, block experiences, and student teaching.

Keywords: field experiences, technology, mathematics, elementary, pre-service, education

Introduction

What is effective use of technology in the mathematics classroom? That is the question mathematics educators should be asking. However, it seems difficult to have that discussion with students in mathematics methods courses because they do not know enough to contribute fully to the discussion. So, when should content-specific technology be introduced to students? Is the senior year too late? There needs to be an earlier introduction to this topic so that students have time to explore and integrate the ideas into their coursework to receive feedback and input from their mentors (Pringle, Dawson, & Adams, 2003).

With the No Child Left Behind legislation in place, the idea of a highly qualified teacher has been a major focus for parents, administrators, and educators. A part of being a highly qualified teacher is being able to use technology effectively in the classroom. Technology plays a role in problem solving and problematic tasks, being a highly qualified teacher, and conceptual focus in the mathematics classroom. Technology is not a static field, and thus the effective use of technology in the classroom is an ongoing challenge (NCTM, 2008). With the wave of reform sweeping mathematics education today, educators must take a step back and consider what is appropriate in the classroom. For example, several institutions have implemented experimental technology-oriented calculus classes in which the proper course, or courses, of action to take in changing the calculus curriculum was investigated (Beckman 1989; Heid 1988; Heid & Edwards 2001). Results indicated students in technology-oriented calculus classes understand the concepts better and have higher retention rates, prompting educators to believe a technology oriented course for calculus is what is needed. Many students experience some form of technology in their classrooms, but do not understand the reasoning behind it (Pringle, et al, 2003).

A highly qualified teacher should be an effective teacher. An effective teacher will strive to learn new techniques, such as integrating technology appropriately, learning new pedagogical skills, staying current with curriculum, and attending workshops and conferences to network with other teachers, all in an effort to continue to be an effective teacher. An effective teacher is willing to step out of his/her comfort zone to try new techniques, technology, etc. Also, an effective teacher pushes the students out of their comfort zones to experience the new and different learning experiences with technology (Kennedy, 2004).

Math educators must provide thorough preparation for students in the world they face today and give them the proper tools to work with before they leave the classroom. Pre-service teachers who engage technology as a teaching tool develop new perspectives on using technology in their teaching (Pringle et al. 2003). In addition, if math educators continue to only teach students in a calculus class to memorize a set of rules for taking derivatives and finding anti-derivatives, etc., they will never realize why they must learn about derivatives and integrals. Math educators should let symbolic manipulators and computer algebra systems (CAS) do the difficult manipulations and computations for the students. By doing this, students can focus more on real world applications and conceptual understanding. Hopefully, this will demonstrate to the students why they need to understand these processes, or at least give them an appreciation for why these ideas are being taught. Tall and Ramos (2004) suggest the use of a computer assists the learner in visualizing the process and concept role of symbols, which reaches great heights in calculus.

“Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning” (National Council of Teachers of Mathematics (NCTM) 2000, Technology Principle). As the mathematical task is what should be

problematic and not computations or graphing, technology is becoming a necessary tool in the mathematics classroom. For example, graphing calculators allow students to focus on the graphs of complex functions they develop in real-world applications without getting bogged down in the difficulties that may arise when graphing by hand. Students' use of technology to engage in real-world mathematics in turn allows them to design and construct their own mathematical experiences. When technology is used according to the *Standards*, it serves as a tool and allows students to focus on the mathematics (Heid, 1997).

The Problem

Many pre-service teachers are seriously lacking in their foundation in technology despite the fact that they grew up in a technology-oriented society. Most pre-service teachers are required to take a technology for teachers' course, and technology is used in their mathematics education courses. Pre-service teachers today have had more exposure to technology in their schooling than any of their predecessors. Yet, somehow, they are not learning to integrate the technology into their classrooms (Kennedy, 2004).

Some technology that exists today has become second nature to mathematics educators, and thus, is not always passed along to pre-service teachers because of assumptions made about their experience (NCTM, 2008). For example, consider a recent experience in a mathematics methods course for elementary teachers. The course consisted of students who were either seniors participating in elementary block (classes that cohort together with a field experience in an elementary school) or seniors who were also completing a field experience with the teacher with whom they will complete their student teaching experience. The discussion in class was regarding upcoming assignments and their formatting, when the topic of notation was mentioned. Several of the students were concerned about the difficulty of mathematical notation and the need to write things in by hand on typed documents. The researchers were quite surprised by this since the students were upperclassmen and had been exposed to numerous field experiences and mathematics coursework. The researchers asked if any of the students had used Microsoft Equation Editor since all of them used Microsoft Word for their word processing needs. Not one of the students was familiar with Equation Editor. So, a session in the computer lab was quickly put on the agenda to rectify the situation.

Students were introduced to the basics in Microsoft Equation Editor, and because they were technology savvy, they were quick to pick up on all the features and needed very little guidance. Students were amazed that Microsoft Equation Editor had been available to them every time they used Microsoft Word, but they were unaware of it. The most surprising comment from a student was, "Why didn't anyone ever tell us about this?" This comment gave the researchers time to think, "She is right. Why hasn't anyone ever told them about this?" The tools are out there, but no one ever gave them to these pre-service teachers to include in their toolbox. This is only one example of information that pre-service teachers are not receiving until late in their degree programs, and sometimes not at all, which has been discovered by working with in-service teachers (Pringle, et al, 2003).

The Solution

Problem solving plays "an essential role in student's learning of mathematical content and in helping students make connections across mathematical content areas" (NCTM 2000, p.

334). NCTM has repeatedly emphasized problem solving in the curriculum. As a result, teachers are encouraged to spend less time on transmission of information and allow more time for students to explore and create mathematics through problematic tasks introduced by the teachers. Since students' perceptions and beliefs about mathematics often stem from the types of activities that occur in the mathematics classroom, real-world applications are an excellent opportunity for students to see the need for mathematics outside of a classroom. Technology allows real-world applications to be more readily used in the classroom (NCTM, 2008).

With the use of technology in the mathematics classroom, students are saved from becoming bogged down in the difficult computations. This allows them to turn their focus to understanding the concepts and how to apply them. Technology also allows open-ended assignments in which the students can learn concepts by "discovery" and are more likely to retain the concepts. The students can also experiment and view different results and methods of solutions to different problems. Without the use of technology, students spend the majority of their time and energy attempting to memorize rules and procedures while using sample exercises as models for their homework problems (Collinson 1999).

Most, if not all of this information is not news to faculty who teach mathematics teacher candidates. It would be difficult to find an educator who would not prefer his/her students to have a conceptual understanding of the mathematics that they will eventually teach. Educators want to pass along their tools to their pre-service teachers, and many of those tools will be shared in methods courses. However, when mathematics pre-service teachers are not taking their methods course(s) until their senior year in college, they are missing out on learning opportunities. Certainly, there are topics and technological tools they are not ready for until they are approaching student teaching. However, there are technological tools they can learn about in their freshman and sophomore years that they could be experimenting with and developing throughout their internships/field experiences leading up to student teaching (Pringle, et al, 2003).

Students should be exposed to technology earlier in their programs so that they have more opportunities to integrate the knowledge into their field experiences. The problem with learning about the integration of technology late in the program is it does not allow for digestion of the material and implementation. With learning about the technologies that exist and how to integrate them late in a program, they may understand the technology, but they still need to gain a thorough understanding of how to teach with it. The pre-service teachers still need pedagogical content knowledge. Several researchers have suggested pedagogical content knowledge should be considered as an indicator of teacher quality (Collinson 1999; Kennedy 2004; Peterson, Fennema, Carpenter, & Loef 1989). It serves no purpose for a teacher to understand the content, but not understand the facets involved in teaching the content to the students. A quality teacher understands how to teach the content. As the No Child Left Behind legislation hangs over pre-service teachers, then this needs to be a concern in our teacher preparation programs (Peterson, et al, 1989).

According to Pringle, et al (2003), technology needs to be introduced early in the program to help pre-service teachers in their internships, field experiences, etc. This will certainly vary based on the different requirements between universities and states. Professional teachers need to be able to produce professional looking materials. First and foremost, the pre-service teachers should be familiar with a software package that allows them to produce quality materials. As one elementary mathematics methods student recently stated, "Equation Editor is awesome!" Certainly, pre-service teachers do not have to use Equation Editor, but software such

as MathType, LaTeX, Scientific Workplace, and TI InterActive allows pre-service teachers to incorporate the appropriate notation, formatting, graphs, etc., producing a professional looking document.

Once the pre-service teachers have the means to produce the professional looking document or activity, they often need help stimulating ideas for what they want to accomplish in the classroom. There are many websites available to students to peruse. However, it is mathematics educators' task to teach them how to determine if the resources they are looking for are appropriate. This ability will get better with experience, so the students will need a point in the right direction. As the students are planning to be mathematics teachers, they could start with the National Council of Teachers of Mathematics' (NCTM) website. NCTM is the largest (with approximately 100,000 members) organization dedicated to improving the teaching and learning of mathematics from prekindergarten through high school. The website offers numerous resources such as articles, position statements, lesson plans, and applets. Over the years, many students have found the site invaluable. A recent student commented, "I love the applets, and I think they are a great addition to the classroom (NCTM, 2008)."

A website that is similar to the NCTM website in terms of applets and lesson ideas is the National Library of Virtual Manipulatives (NLVM). The site contains web-based virtual manipulatives or concept tutorials, mostly in the form of Java applets, for mathematics instruction (NLVM 2008). Again, students can integrate the applets into the classroom or use the suggested activities on the site to stimulate a complete lesson. There are numerous other resources out there for the pre-service teachers. The important point is to introduce the students to some of the resources early in their program so they can begin to integrate and implement the technologies into their internships/field experiences so that they can develop their technological toolbox and become comfortable with using those tools (Pringle, et al, 2003).

Conclusion

The authors consider this work a good beginning. It is hoped other mathematics educators will consider the introduction of technology earlier in pre-service teachers' programs and how that affects the pre-service teachers in the classroom. Additionally, the authors hope mathematics educators will share innovative ways they introduce the technologies to the pre-service teachers, whether it be integrated in a content class, or through a content-specific technology course.

Technology is a large part of our world today. Simply grinding through many complicated computations will not keep the students' attention. The technology gives the students something to be excited about and look forward to instead of the traditional lecture format. Therefore, mathematics educators have a responsibility to do everything in their power to further the education of future students to the best of their ability. Using technology in the mathematics classroom is not just an option anymore; it is a necessity.

Further research is necessary to determine the overall implications of introducing technological resources to pre-service teachers early in their programs. However, if the early introduction helps even a few pre-service teachers be better equipped during internships and field experiences, then the early introduction may be worth the effort.

References

- Beckmann, C. E. (1989). Effect of computer graphic use on student understanding of calculus concepts. *Proceedings of the Conference on Technology in Collegiate Mathematics* (pp.114 - 117). New York: Addison-Wesley.
- Collinson, V. (1999). Redefining teacher excellence. *Theory into Practice*, 38(1), 4 - 11.
- Heid, M. K. (1988). Resequencing skills and concepts in applied calculus using the computer as a tool. *Journal for Research in Mathematics Education*, 19(1), 3-25.
- Heid, M. K. (1997). The technological revolution and the reform of school mathematics. *American Journal of Education*, 106(1), 5 – 61.
- Heid, M. & Edwards, M. (2001). Computer algebra systems: Revolution or retrofit for today's mathematics classrooms? *Theory into Practice*, 40(2), 128 – 136.
- Kennedy, M. (2004). Examining teacher quality. In F. K. Lester & J. Ferrini-Mundy (Eds.), *Proceedings of the NCTM Research Catalyst Conference*. Reston, VA: National Council for Teachers of Mathematics.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2008). *Frequently asked questions*. Retrieved from http://nctm.org/about/faq.aspx?id=164&ekmense1=c57dfa7b_624_0_164_1.
- National Library of Virtual Manipulatives. (2008). *Site information*. Retrieved August 8, 2008, from http://nctm.org/about/faq.aspx?id=164&ekmense1=c57dfa7b_624_0_164_1.
- Peterson, P., Fennema, E., Carpenter, T.P., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. *Cognition and Instruction*, 6(1), 1 - 40.
- Pringle, R., Dawson, K., & Adams, T. (2003). Technology, science and preservice teachers: Creating a culture of technology-savvy elementary teachers. *Action in Teacher Education*, 24(4), 46 – 52
- Tall, D. & Ramos, J. (2004). Reflecting on post-calculus reform. Paper presented at Annual meeting of International Congress on Mathematics Education Teaching Subgroup 12.