# PREPARING PERSERVICE MATH TEACHERS TO TEACH WITH TODAY'S TECHNOLOGY: KEEPING THEM UP TO DATE

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## INTRODUCTION

The focus of this article is on a revised course titled "Tools and Technology for Secondary Mathematics". We often refer to this course as our "Technology Methods Course". Because of the many technologies available that can assist a mathematics teacher's delivery of instruction, I have revised our course to be more selective than prescriptive. That is, rather than my deciding what particular technologies (and only having time to look at a few), such as which calculators, which mathematical software programs, and which delivery systems I would provide instruction, I identify, demonstrate, and describe several high quality technologies for mathematics instruction and then let the student decide on any three modern technologies in which they are most interest and would like to pursue for their course projects. They really enjoyed this independence in selecting technologies of their interest and in extending their knowledge and skill at using different technologies for math instruction. After all, a teacher is likely to use technology as part of their classroom instruction if they enjoy the technology and are comfortable at using it. Because they present their projects, the class is exposed to many different technologies for instruction and thus has a broader perspective as to possible tools for teaching mathematics.

Having a few pet technologies, I make class presentations during the semester on those in which I really want them to become familiar, such as: *Geometer's Sketchpad* or *GeoGebra*, *TI-Nspire*, and some form of video podcasting, such as *Camtasia* or *Jing*.

Although I have taught the technology methods course for a few years, this revised course, I taught for the first time during Spring Semester 2011, and received very positive feedback from the students.

Technology is a vital tool for mathematics instruction in classrooms. Unfortunately, this tool is frequently underutilized by even the most skilled teachers due to the lack of experience in using instructional technology. Thus, it is an important mission of institutions of higher education who prepare mathematics teachers to help the next generation of teachers to become effective users of technology for mathematics instruction. Undergraduate professional development needs to provide future teachers with experiences that enable them to be knowledgeable, skilled, and comfortable at using up-to-date technology for daily mathematics instruction. This article includes

technology examples used in preparing future math teachers, whether they go on to teach in a technology rich school district or one with little technology. These experiences also empower future teachers to become advocates for having quality technology in their school.

## RECOMMENDATIONS FROM PROFESSIONAL GROUPS

In recent years, several national organizations have continued to promote the appropriate use of technology in mathematics education by making statements about the professional development of future teachers. NCTM has recommended that preservice mathematics teachers be given appropriate preparation in the use and integration of technology for day-to-day teaching that takes advantage of technologically rich environments for the learning of mathematics. Additionally, the Association of Mathematics Teacher Educators (AMTE, 2006) has given the following advice for those who prepare pre-service teachers.

> Mathematics teacher educators should provide opportunities for teacher candidates to strengthen their knowledge in incorporating technology to facilitate student learning of mathematics through experiences that:
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> - allow teacher candidates to explore and learn mathematics using technology in ways that build confidence and understanding of the technology and mathematics;
> - model appropriate uses of a variety of established and new applications of technology as tools to develop a deep understanding of mathematics in varied contexts;
> - help teacher candidates make informed decisions about appropriate and effective uses of technology in the teaching and learning of mathematics; and
> - provide opportunities for teacher candidates to develop and practice teaching lessons that take advantage of the ability of technology to enrich and enhance the learning of mathematics. (p. 2)

Finally, the Conference Board of the Mathematical Sciences (2001) and the International Society for Technology in Education (2008) have recommended that teacher education programs provide a structure for helping their undergraduate students to understand and use technology throughout their teaching careers.

Despite these recommendations from national organizations, many teacher preparation programs have fallen short in their technology instruction. In a study of college pre-service teachers, Smith & Shotsberger (2001) determined that future mathematics teachers do not feel prepared to teach mathematics using technology. It was increasingly clear that although calculators and computers were integrated into students' classroom experiences in several of their undergraduate mathematics courses (e.g., in the calculus sequence and in a mathematics modeling course), it was not sufficient experience for entering the teaching profession. Future teachers need

experiences using modern technology not just as a learner of mathematics but also as a teacher of mathematics (Niess, 2006).

AMTE believes that students at all levels, PreK-20, gain from technology-enriched learning. The organization also provides guidelines for the design and development of technology-enhanced learning, the facilitation of instruction with technology as an integrated tool, the assessment and evaluation of technology-enriched mathematics, and the engagement of professional development to enhance technology pedagogical content knowledge (AMTE, 2009).

## A COURSE FOR FUTURE MATHEMATICS TEACHERS

The author began teaching this mathematics "technology" methods course in 2005. This two-semester hour course is a requirement of all majors in secondary school mathematics. Although many fundamental concepts of mathematics from number and operations at the middle school level to abstract algebra at the undergraduate or graduate level of the university can be enhanced through technology (NCTM, 2003). This technology course focuses on topics contained in such secondary school level courses as: pre-algebra, algebra, trigonometry, geometry, statistics, pre-calculus, and some calculus. The course has been designed to prepare students to be knowledgeable, skilled, and comfortable at using technology with their future students. The teacher candidates have hands-on experiences in teaching and using such technologies as: graphing calculators, dynamic geometry software, dynamic data analysis software, computer algebra systems, Internet mathematical resource, online calculators, dynamic mathematics software applets, the interactive whiteboard, video podcasting, and tablet computers.

Although the students come into the course with various technology skills acquired in their previous high school and college mathematics classes, their experiences are only from a student's perspective, and do not transfer to teaching secondary level mathematics. Because of this, the course provides practical opportunities for the students to learn the technology from an instructor's point of view, to examine the interaction between the mathematics content and the technology, and to simulate use of the technology as if teaching in a secondary level mathematics classroom situation.

Some of the specific technology featured in the course such as: handhelds, the Internet, various computer applications, and interactive whiteboard are addressed below.

### Handhelds

Because of the prevalence of graphing calculators in secondary mathematics classrooms, teacher candidates spend time examining this technology from a teacher's perspective. For example, they might use it to teach about multiple representations of a family of functions and then write related questions for which algebra students would address. Now if selected as a technology of choice, a student can choose to collect

various data with probes and sonic devices and then use a calculator to view, analyze the data and teach the concept to the class. Also if chosen as a project, a student can link their calculator to their computer for downloading applications and programs, as well as uploading data or graphics into a word processing, spreadsheet or other software application document for classroom demonstrations of mathematical concepts and as computer lab activities for their future secondary level students.

## Internet

These future teachers view the Internet as a tool for mathematics instruction. Candidates are first required to go online to read the short version of NCTM's *Principles and Standards of School Mathematics* (www.nctm.org/standards), view and participate in several of NCTM's *Illumination* applet activities (illuminations.nctm.org), and a few other high quality websites for instruction in high school mathematics such as *Eisenhower National Clearninghouse (goENC.com)*, *MathTools* from Math Forum (mathforum.org/mathtools), and *PBS TeacherLine* (www.pbs.org/teacherline). These experiences provide them with a sense of what mathematics topics can be presented and learned effectively within a technological environment. In addition to having access to quality websites for instruction, the teacher candidates learn to use and teach with exemplary applets related to the lessons. For example, *The National Library of Virtual Manipulatives* from Utah State University (nlvm.usu.edu) provides an array of free online or desktop versions of several virtual manipulatives applicable for all the NCTM Content Standards for secondary as well as elementary mathematics. *Resources for Learning to Teach Mathematics with Technology* at Brigham Young University (www.mathed.byu.edu/~kleatham/Technology/INDEX.html), as the title suggests, contains resources from handhelds to software to java tools, which is a valuable Internet site for those learning to teach mathematics with technology. In all, the students are given a list of approximately 30 or so sites to visit and write a brief abstract on each. The purpose of this assignment is to help them become aware and a bit acquainted with appropriate sites that they may want to use in the next year or two, when they become the classroom teacher.

Students are shown video podcasting of mathematics lessons and are given the opportunity to develop and present their own mathematics lesson to the class. Some may choose to do video podcasting, and conduct a "flip-classroom" lesson. The flip-classroom exchanges activities that are commonly done in the classroom and activities assigned as homework. In the flip-classroom, classroom time is spend on questions and answers regarding the concepts of the lesson and the assigned problems that were presented as a video podcast on *YouTube* to be viewed by each individual student the night before.

## Computer Applications

While gaining insights in teaching with technology from the Internet, future teachers learn about and begin teaching with various software packages applicable in secondary

mathematics classrooms. The candidates work with the *Geometer's Sketchpad* or *GeoGebra* to address secondary school geometry; they collect data, view, and analyze the data with *Fathom* to address high school courses in probability and statistics; if selected as a project, some will gain experience, from a teacher's point of view, in using a computer algebra system (CAS) for mathematics instruction. Through the integration of a CAS and dynamic software, the undergraduate can manipulate geometric objects, data, functions, and graphs looking for patterns and relationships. They also have the opportunity to organize their thinking and respond to the thought-provoking questions presented by the instructor or developed through their own questioning. Finally, many of these applications allow for written communication among classroom participants via text windows where candidates can write their discoveries, conjectures, and conclusions.

### Interactive Whiteboard

In addition to learning to conduct effective instruction with individual tools such as graphing calculators and computer software, these teachers candidates also gain experience with such whole-class instructional tools as a document projection cameras and interactive whiteboard. Some of the students use the document projects to present to the class activities involving graphing calculators. Since many schools have interactive whiteboards (e.g., the *SMART Board* and *Promethean*) we make sure that our students are given experience with this technology as well. They typically use the interactive whiteboard when they present their projects to the class. They also use it to demonstrate computer applications or in learning how to use such applications as the *TI-Viewscreen*, *Ti-nspire Teacher Software*, or *TI-nspire emulator* software from Texas Instruments. Each student finishes the course by teaching high school mathematics lessons to the class using more than one form of technology.

## SKILLS

After gaining a basic knowledge level with these tools the undergraduates are required to develop skills for implementing technology appropriately in classroom instruction. Specifically, these teacher candidates develop discovery lessons for their future math students utilizing handheld graphing calculators and computer applications identified above. The idea is to learn how to match an appropriate technology with a mathematics topic before going into a mathematics classroom as "the" classroom teacher. In Figure 1, below, is displayed a lesson activity from a candidate on reflection symmetries for high school geometry. This future teacher utilized the interactive characteristics of a dynamic geometry software package to show the relationships between the measures of the angles, the sides, and the coordinates of the vertices of a triangle and those of its reflected image.

These preservice teachers are required to develop skills for implementing technology in assessments as well. Using data collected from the class and presented in spreadsheet form, the candidate asked students to identify various displays and to calculate

descriptive statistics of the data. Such use of technology allowed this candidate to create professional-looking documents for classroom instruction.

All of the skills for using technology in instruction and assessment are beneficial for future teachers and make it easier for them to understand the role of technology in mathematics instruction. By beginning their teaching career with knowledge and experience in using technology for instruction, these future teachers expect to use technology in their classrooms.

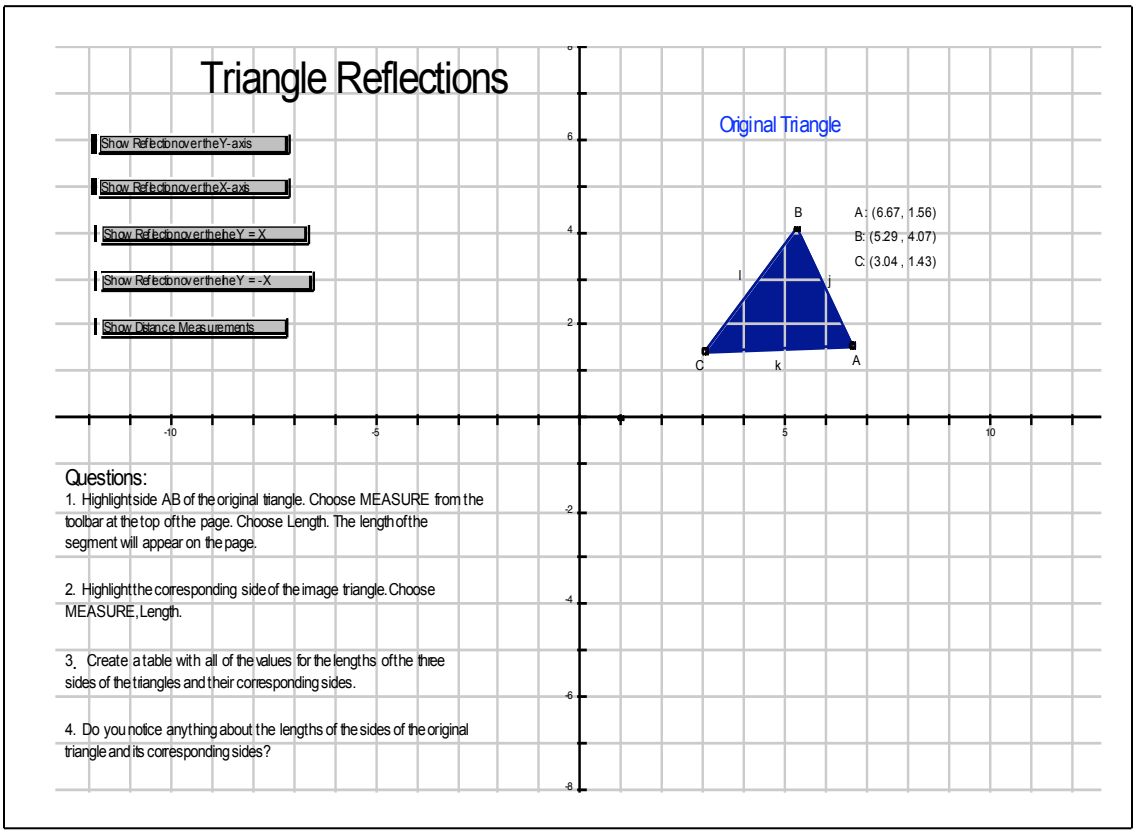


**Fig. 1** Lesson activity on reflections using a dynamic geometry software package.

Technology through video examples illustrate how technology can increase the speed in which students are not only presented mathematical concepts but have the potential to change the ways in which teachers and student think about mathematical ideas (Lee & Hollebrands, 2008).

The demands of the course in the use technology to develop classroom presentations, computer lab explorations, student in-class and out-of-class assignments, as well as assessments are a source of uneasiness at first. However, about midway though the semester the candidates begin to gain confidence in their ability to use these instructional tools to develop lessons for secondary mathematics students. They begin

to perceive themselves as classroom teachers who are or will become comfortable in using the technology.

## CONCLUDING REMARKS AND CHALLENGES

The focus of this teacher preparation course, as much as possible, is on the mathematics and not just on the technology. That is accomplished by addressing concepts and topics in mathematics that are best learned through a particular technology. However, because of the time required to obtain even a beginner's level in using new technology, time must be spent on learning the technology, but all in the context of topics of secondary school mathematics. As these college students become reacquainted with some of their middle school and high school mathematics, they gain some experience in actually developing and conducting a lesson that includes the use of high quality and appropriate technology.

As technology is dynamic and continues to change, this mathematics technology course varies a bit from year-to-year. For example, a few years ago we purchased the *TI-Navigator* System to be used and tested in College Algebra. Students in the technology methods course had the opportunity to add this technology to their repertoire for teaching high school mathematics. Also, because different schools have different technologies, we believe that each student needs to be comfortable and capable in using a variety of tools for mathematics instruction. As a result, a most important goal of this course is to develop a positive disposition toward learning new technology tools, especially as they are ever changing and new ones becoming available.

Ultimately, mathematics teacher preparation programs must ensure that all mathematics teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology within the context of teaching and learning mathematics (Niess, 2006).

If interested in more information on the course described in this article, please feel free to contact the author for a copy of the course syllabus or to discuss any aspects of the course.

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