TECHNOLOGY USE IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

by

Heather Prestegord

A Research Paper Submitted to the Faculty of the
DEPARTMENT OF Mathematics and Computer Science

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE IN Mathematics

BEMIDJI STATE UNIVERSITY
Bemidji, Minnesota, USA

August 2011

STATEMENT BY AUTHOR

Signed: _____

_____

APPROVAL BY THESIS/RESEARCH PAPER ADVISOR

THIS RESEARCH PAPER HAS BEEN APPROVED ON THE DATE SHOWN BELOW:

_____ _____

Glen Richgels, Date
Committee Chair
Professor of Department of Mathematics and Computer Science

_____ _____

Dean, School of Graduate Studies Date

TECHNOLOGY USE IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

Heather Prestegord

This paper will examine the outcomes of using technology in middle school mathematics. The author will find research on how implementing technology affects students' ability to learn mathematics. The author will also analyze if teachers are incorporating technology effectively and how teachers can be better equipped to successfully use technology in the middle school mathematics classroom.

Approved by

_____ _____

Committee Chair Date

_____

Committee Member

_____

Committee Member

_____

Graduate Faculty Representative

ACKNOWLEDGMENTS

Thank you to Joan Miller, Nancy Van Erp, Todd Fraunholtz, Glen Richgels, Craig Rypkema, and Gus Vettleson for their assistance in writing this paper. I appreciate their hours of support and dedication. For their consistent kindness and willingness to help I will always be grateful!

TABLE OF CONTENTS

Chapter 1: Introduction

Technology is becoming increasingly more prevalent in today's society. Most teachers have access to at least one form of technology, and today's students will likely be using technology in their future careers. It is common in some public school classrooms to use multiple forms of technology each day.

The purpose of this study is to

1. research on the effects of technology in the middle school mathematics classroom
2. identify research that has been conducted about teacher implementation of technology and
3. explore the ways teachers can be trained effectively to use technology in their classrooms.

Statement of the Problem

In today's middle school mathematics classrooms, various forms of technology are likely available. Yet, it seems there is hesitation to use those forms of technology. Teachers, administrators, and parents are concerned that using technology may be a hindrance in students' learning. In the middle school mathematics classroom, some educators fear that students will become too reliant on technology and not learn their "basic facts" or understand the process of problem solving. Through this author's observations, various forms of technology are also not being used because teachers lack training and therefore, confidence. Consequently, students may be missing out on some forms of technology that could be of great benefit to them as they learn mathematics in the middle school classroom. Additionally, some school districts are dedicating valuable

resources to purchase technology and, if it is not being used, one must ask if this is money well spent.

Research Questions

- Technology in the middle school mathematics classroom
    - What are the forms of technology available to the middle school mathematics classroom (such as calculators, computers, and interactive whiteboards)?
    - What are the effects of technology on skill building, concept building, and problem solving?
    - What are the positive effects of technology in middle school mathematics classroom? Is technology in the middle school mathematics classroom helping students develop a better understanding of mathematics?
    - What are the negative effects of technology in middle school mathematics classroom? Does teaching with technology deter students from developing a solid understanding?
- Preparation and professional development for teachers
    - What preparation do pre-service teachers receive with respect to technology?
    - What professional development is available for in-service teachers?
    - Are teachers learning how to teach the technology or how to teach mathematics using technology?
    - What types of training are effective for teachers to implement technology?

Significance of the Research Problem

The use and development of technology is continually increasing in the 21st century. Today's middle school students will be expected to use technology (such as

various calculators, interactive geometry software, spreadsheets, *etc*.) in their high school mathematics classroom, and they are likely to pursue careers that include technology.

There is great significance in researching the effectiveness of technology in the middle school mathematics classroom, as shown by the following statements:

- Hollenbeck and Fey (2009) stated, "When electronic information technologies are applied to the tasks of teaching, they provide intriguing opportunities for transforming the mathematics learning experience" (p. 431).
- "According to a National Center for Education Statistics survey, 99 percent of full-time regular teachers reported having access to computers. Only one-third felt prepared to use them in the classroom" (Jones, 2001, p. 35).
- "Most schools of education have not yet fully integrated technology into their programs for preparing teachers" (National Council for Accreditation of Teacher Education [NCATE], 1997, p. 5).

Administrators, teachers, and parents want students to learn mathematics well and reach goals set by state and national standards. If using technology can be a significant aide in that process and can help students gain a deeper understanding of mathematics, then we need to implement more technology into our mathematics classrooms, including at the middle school level. If more technology needs to be implemented, then we need to discover how that can be done effectively. If technology is not useful in learning mathematics, then we need to keep it out of the classroom.

Limitations and Assumptions

I am limiting my research by referring solely to 5-12 mathematics education. I am using past and current research on technology as well as focusing on current ways to effectively equip teachers to use technology effectively in the classroom.

Definition of Terms

MCTM – Minnesota Council of Teachers of Mathematics

NCTM – National Council of Teachers of Mathematics

Technology – Electronic tools that one might find in a United States 21st century mathematics classroom such as computers, calculators, etc

EAI- Enhanced Anchored Instruction

BAU- Business as Usual

TIME- Technology in Mathematics Education

Chapter 2: Review of the Literature

Forms of Technology Available to the Middle School Mathematics Classroom

For this paper, the author previously defined technology as "Electronic tools that one might find in a United States 21st century mathematics classroom such as computers, calculators, etc." Limitless forms of technology are available for today's middle school mathematics classrooms. A few examples of technology that the author will report on in this paper are listed below:

- A *"Clicker"* (or personal response system) is a response pad that "wirelessly connects to a system that projects the teacher's questions onto a screen in front of the classroom" (Matassa, 2006, para. 3). Students are able to anonymously submit answers to questions. One way middle school math and science teacher Megan Fisk (Matassa, 2006) uses clickers is asking her students if they can see what an incorrect answer should have been. Then, each student enters what they believe to be the correct answer into their clicker (Matassa, 2006).
- An *interactive whiteboard* is

  > a touch-sensitive board allows users to interact directly with applications without having to be physically at the computer which is projecting the image onto the board. Elements of text, graphics, sound, animation, and video help teachers create lessons that interest and engage students during the learning process. (Beeland, 2002, p. 1).

  NCTM's Illuminations website (National Council of Teacher of Mathematics) lists various interactive whiteboard activities that be used in a middle school

mathematics classroom. A few examples of these activities are virtual Fraction Models, Algebra Tiles, and Tessellation Creator.

- *Fractions at Work* is a software package, showing a skate-board ramp park on its main menu. It was created to

  > improve students' conceptual and procedural knowledge of fractions by illustrating the parts of a faction, equivalent fractions (e.g., shown on a ruler), and ways of using knowledge of equivalent fractions to add and subtract fractions with like and unlike denominators. (Bottege, Grant, Stephens, & Rueda, 2010, p. 87)

- *Fraction of the Cost* is multimedia-based instructional package which "presents a story of three friends who want to build a skateboard ramp" (Bottege et al., 2010, p. 87). Throughout the process, students use fractions to "cut" the materials needed all the while needing to be efficient with their measurements and calculations so they don't waste materials and because the friends only have so much money to purchase the supplies needed to build their ramp. Another feature offered by this program is interactive scaffolds. "For example, students were able to rotate a color-coded skateboard ramp to see all sides and identify parts of the ramp that were the same length" (Bottege et al., 2010, p. 88).

- The use of *computers* is growing in various middle school mathematics classrooms, specifically the use of *laptops*. For example, the Maine Learning Technology Initiative began in 2002, "when every seventh grade student and teacher in every public middle school received a laptop, for a total of 20,000

laptops in use" (Education Development Center, Inc., 2003, para. 2). In 2004, the initiative was extended to provide laptops for all seventh and eighth graders in public middle school.

- Numerous *calculators* are available for use in middle school mathematics classrooms, including *graphing calculator*s. The article "Graphing calculators as tools" (Browning & Garza-Kling, 2010) focused on four ways graphing calculators can be used to explore mathematic concepts in the middle school math classroom. The *TI-73* graphing calculator is specifically designed for 6th-8th graders (Texas Instruments, 2011). The article "TI-73 Calculator activities" (Philllips-Bey, 2004) describes various mathematics activities for middle school students.

Effects of Using Technology in the Middle School Mathematics Classroom

Various studies have been conducted to determine the effects of using technology in the middle school mathematics classroom. In this section, the author will give a brief report of examples of such studies as well as the results thereof.

The 2009 article "Technology and mathematics in the middle grades" (Hollenbeck & Fey, 2009) begins by explaining that mathematics in the middle school classroom is being transformed by technology. "Many middle-grades mathematics classrooms already provide an impressive array of technological tools. In some schools, access to tools is the easy part. Figuring out how to use the tools effectively and appropriately is a far greater challenge" (Hollenbeck & Fey, 2009, p. 431). One of the goals of this article was to persuade teachers to use various technologies in their

classroom. The authors emphasized the "need and direction for change in middle-grades mathematics" (Hollenbeck & Fey, 2009, p. 431).

For each NCTM strand in middle-level mathematics, this article gives a specific example of how using technology can be used to effectively teach a certain topic. For example, in the Geometry strand, it explained how using the National Library of Virtual Manipulatives can be a very useful tool to teach the area of a triangle (Hollenbeck & Fey, 2009). In each specific example, the authors explained what students could gain by using technology, including having visual and spatial representations, instant feedback, and the ability to easily access data relevant to middle-school aged students.

Technology can also be used to assess students in a way that can provide meaningful information for teachers and students (Hollenbeck & Fey, 2009). "Clickers" for example, can provide instant feedback, so that instructors can adjust their teaching accordingly. Students can also easily share and explain their work with peers and teachers, which builds understanding and confidence. Teachers may also use technology for students to ask questions outside of class or to submit a homework assignment.

Another study was conducted in six intact, required technology education classrooms (Bottege et al., 2010). Each classroom was assigned to an explicit Enhanced Anchored Instruction (EAI) condition, an embedded EAI condition, or a Business as Usual (BAU) condition. The explicit EAI condition included "a fractions module, a multimedia-based problem-solving module, and a hands-on problem" (Bottege et al., 2010, p. 84). The embedded EAI condition included "two multimedia-based problem-solving modules and a hands-on problem" (Bottege et al., 2010, p. 84). In the BAU condition, teachers continued with their usual teaching methods.

Each group of students was given various Pre- and Post- Tests. On a *Fraction Computation Test*,

> The Embedded instruction group showed a statistically significant improvement over the BAU group, but there was no additional improvement by the Explicit group over the BAU group…Students in the Embedded condition showed greater improvement than students in the BAU condition on the following items: computing with like denominators, computing with fractions found on a ruler, and subtraction items. (Bottege et al., 2010, p. 96)

On a *Problem-Solving Test*, "results showed students who were taught with either version of EAI outperformed students in the BAU condition" (Bottege et al., 2010, p. 98). On two segments on an *Iowa Test of Basic Skills,* no significant differences among the groups were found. The authors did not find this discouraging, however, because the students in the BAU group were allowed to take part in the hands-on problem and they believe that learning will occur with engaging activities. By using math in the technology classroom, students are seeing the usefulness of mathematics as well as how it might help them in their futures.

The authors felt that there may have been too few schools in the above study to get an accurate depiction of the learning that was present. Therefore, the authors plan to do a similar study in the near future, involving 34 middle schools. "The findings from that study should help us to more confidently assess the effects of EAI." (Bottege et al., 2010, p. 101).

Hollenbeck & Fey (2009) pose numerous questions that debate the optimal amount of time spent on calculation methods and the amount of time spent using

technology to interpret various calculations. The authors leave the reader with one final thought: “Given the urgency of providing strong mathematical preparation for students who will enter and live in a technologically sophisticated society and workplace, such a study and experimentation by all involved in mathematics teaching should be a high priority” (Hollenbeck & Fey, 2009, p. 435).

In another article, Denise Jarrett (1998) discussed the importance of integrating technology in the middle school mathematics classroom. As students are at various stages of development, technology can help teachers accommodate to a wide-range of ability levels. Technology can also play a crucial role as students are beginning to think abstractly; it can help them move from concrete to abstract thinking. “Technology can help teachers respond to students’ diverse learning styles by creating rich environments that engage students’ tactile, visual, and auditory senses” (Jarrett, 1998, p. 5). This article explains that even though teachers debate about the effects of technology in the classroom, technology has been shown to help develop higher-lever thinking skills, writing skills, problem solving strategies, etc.

In another study, a laptop program was implemented in a predominately low-income, minority school. “Both quantitative and qualitative data were collected, analyzed, and compare with students in non-laptop classrooms within the same school” (Mouza, 2008, p. 447). The study found that, in classrooms where the teacher was able to implement technology effectively, disadvantaged students were enabled, through laptop use, to participate in engaging learning situations. “Laptop programs represent an important class of initiatives in the field of educational technology because of their

increased popularity and their potential to bridge the digital and didactic divide that currently exists in schools" (Mouza, 2008, p. 469).

In the article "Using graphing calculators in the montessori middle school classroom," Margaritis explained that if students develop their basic skills without using calculators, then using calculators at the middle school level does not threaten basic skills. The author strongly encourages the use of graphing calculators.

> First, they incorporate a portable learning environment that may be used both at school and home. Second, if used correctly, they provide the students with a tool that fosters learning and thinking by providing immediate feedback that will support their reasoning. (Margaritis, 2003, p. 42)

Margaritis (2003) explained that graphing calculators allow students to visualize their calculations and discover their errors. The large screen can be useful, even in a lesson such as learning the order of operations. Also, students can look at two equations at the same time, on the calculation screen, or on a graph.

> Consider the fact that all of the following skills may be developed through the use of graphing calculators: numerical skills, symbolic skills, graphical skills, and finally translation skills- all necessary to create self-reliant, empowered individuals who will not be afraid to use their imaginations in order to conquer a new idea. (Margaritis, 2003, p. 43)

In the article "Integration of technology, curriculum, and professional development for advancing middle school mathematics: Three large-scale studies" (Roschell, et al., 2010), the authors state that there is much evidence that middle school math needs improvement. In fourth grade, US students compare favorably with

international peers. However, in 8th grade, US students fall behind their peers. The authors explain that middle school is an important time mathematically for students. Students learn about abstract concepts regularly and most students are not used to the rate at which the middle level mathematics difficulty increases. The article states many ways technology can be useful and the authors concluded that "technology supports both computation and representation" (Roschell, et al., 2010, p. 837).

Preparation Pre-Service Teachers Receive with Respect to Technology

In 2000, the national educational technology plan was published by the United States Department of Education. It said that "new teachers entering the profession are still not being adequately prepared to teach with technology" (U.S. Department of Education, 2000, p. 14). It also found that "fewer than half of the nation's teacher preparation institutions require students to design and deliver instruction using technology, and that even fewer require technology use in the student teaching experience" (U.S. Department of Education, 2000, p. 14).

Smith and Shotsberger (2001) found that many pre-service mathematics teachers do not feel prepared to teach mathematics using technology. Blubaugh (2009) stated that "teacher preparation programs need to focus on strengthening the pre-service teachers' knowledge of how to incorporate technology into classroom instruction" (p. 42).

In the article "Lessons from the field: Integrating technology into pre-service education" (Brush et al., 2002), Arizona State University professors and graduate students explained that one way to help teachers become better at integrating technology in their subject area is to include aspects of integrating technology in their undergraduate methods courses.

Arizona State University developed a new model for pre-service teachers. The College of Education identified three key components of a model designed to provide pre-service teachers with the skills and experiences required to fully integrate technology into their future classrooms. These components include:

1. Providing pre-service teachers with field based, situation-specific technology training they are able to integrate into the initial teaching activities they complete as part of their teaching methodologies experiences. These experiences represent the major component of their teacher education program, beginning in their junior year (the first year they are in the teacher education program) and continuing until they begin student teaching.
2. Providing ongoing, field based support to pre-service teachers throughout their student teaching experiences in order to help them utilize technology in the activities they design for their classes, and including technology integration as part of the overall evaluation of their student teaching.
3. Providing College of Education faculty and field-based mentor teachers with training, guidance, and just-in-time assistance as a means to more effectively enable them to support pre-service teachers with technology integration activities. Part of this involves the delivery of several "summer institutes" designed to provide faculty and field-based mentors with opportunities to learn how to integrate technology into their teaching. (Brush et al., 2002, pp. 5-6).

Professional Development Available for In-Service Teachers

The article "The effects of mentor-supported technology professional development on middle school mathematics teachers' attitudes and practice" (Swan &

Dixon, 2006) emphasized that although billions of dollars have been spent on technology in classrooms, a very small percentage of those dollars have went toward teacher training, and much of the technology is not being used effectively.

The authors of this article conducted research intended to answer the following question: "How does the practice of a teacher mentor and peer technology trainer affect teacher use and attitude toward technology in mathematics middle school classrooms?" (Swan & Dixon, 2006, p. 2)

Throughout the study,

> four major themes emerged: teachers were concerned with barriers related to the availability of technology: teachers found training useful and desired to use technology more frequently; teachers desired and needed continued and ongoing technology training; and teachers were concerned about the lack of release time for training, planning, and collaboration. (Swan & Dixon, 2006, p. 8)

The article proceeded to give further detail about each of those themes.

Jarrett explained, "There is little doubt that learning to teach effectively with technology requires a significant commitment by the teacher" (Jarrett, 1998, p. 6). She said that if teachers make small goals in working with technology, every year they will be able to incorporate it a little more.

Jones (2001) explained that teacher readiness is critical in incorporating technology in classrooms. Teachers face several challenges when incorporating technology in their classrooms including learning new software, developing lesson plans that integrate technology, and lack of time to learn about technology and its uses.

Teachers who are trying to incorporate technology often look to peers for assistance or they look to online resources for help. Jones (2001) suggested that administrators become more involved with technology, so they can then assist their teachers. Administrators can model using technology at meetings as well as allot time for technology workshops and time for teachers to spend learning about technology. For teachers who do not feel comfortable with technology, one-on-one mentoring is needed, either by an administrator or technology coordinator (Jones, 2001). In agreement, Bottege et al., 2010 stated, "While curriculum specialists and committees often decide how mathematics is taught, it is ultimately principals who influence the extent to which these initiatives are carried out" (p.84).

To prepare for the EAI study (Bottege et al., 2010), which the author mentioned in a previous section, teachers "participated in a 2-day workshop during the summer, which was taught by a middle school math teacher who had used EAI in his classes for several years" (Bottege et al., 2010, p. 90). Additionally, teachers were provided with thorough daily lesson plans. "During the workshop, teachers solved problems with fraction strips, watched the problem-solving videos, and solved the practice problems" (Bottege et al., 2010, p. 90). They also had a chance to participate in the same hands-on activity their students would. Before the study took place, the teachers were able to "practice" the unit in their first quarter class, with students not involved in the EAI study. "These teachers stressed that this practice period improved their familiarity and confidence with the curriculum and increased the quality of the teaching that took place during the study" (Bottege et al., 2010, p. 90).

If students are given access to technology and their teachers are equipped to integrate it in the classroom, technology offers a way for disadvantaged students to have equality of digital opportunities (Mouza, 2008). Technology will likely also help underprivileged students in their future career.

Learning How to Teach the Technology vs. Teaching Mathematics Using Technology

In the article, "It's TIME for technology: The technology in mathematics education project," Hardy (2008) stated, "In- and preservice teachers have often criticized how their teacher education programs sought to prepare them to teach with technology" (p. 221). Hardy (2008) explained, "Teachers and teacher candidates have also asserted that a single educational technology course was insufficient to prepare them to teach with technology" (p.222). Such courses usually do not help teachers *teach with* technology but instead teach them *about* technology (Hardy, 2008).

Grabe and Grabe (1998) also found that teacher preparation courses focused on how to use the technology rather than be able to orchestrate learning through technology. Pope (2002) explained that there is a significant gap between what pre-service teachers learn in required technology courses and how they are expected to teach using technology once they are in the education field.

Effective Trainings for Teachers to Implement Technology

The Technology in Mathematics Education (TIME) Project was developed out of the need for teachers to learn how to teach mathematics using technology (Hardy, 2008). One goal of this project was "to help middle and secondary mathematics teachers broaden their knowledge of technological resources and methods of using them to teach mathematics" (Hardy, 2008, p. 222). During the summer of 2003, nineteen middle or

high school mathematics teachers participated in training courses which focused on ways of teaching mathematics through technology use.

> The technology-related topics explored in the courses included using videos to motivate or elaborate on instruction; using PowerPoint to enhance lectures; using Geometer's Sketchpad, graphing calculators, and spreadsheets to solve problems, teach concepts, and link mathematics to realistic contexts; locating and using internet resources; writing plans for technology-infused lessons (Doering et al., 2003, Martin et al., 2003); exploring criteria for evaluating software; and critiquing software or other technological resources. (Hardy, 2008, pp. 224-225)

Teachers were offered much additional support, including follow-up sessions throughout the following school year and exposure to additional activities and resources (Hardy, 2008). They were provided with "first-hand experience using the technology within the context of activities that they could use with their pupils" (Hardy, 2008, p. 226).

The TIME Project was successful. Teachers gained knowledge about available technology and felt more prepared to teach mathematics using technology. Additionally, the teachers' beliefs about using technology were greatly improved (Hardy, 2008).

The developers of another project, the LOGO project, realized that teachers typically participate in workshops and trainings that are administration mandated, in which they are told what to teach and which teaching strategies they should implement (Stevens, To, Harris, & Dwyer, 2008). By contrast, the designers of the LOGO project wanted to develop an in-service program in which teachers would feel more competent,

feel confident to utilize their knowledge and skills more effectively, and grow in self-determination. The LOGO creators

> believe that teachers who are collectively involved in the development and refinement of their own classroom materials will have an increased ownership of those materials, display more effective application on those materials, and continue the learning process as they work together to continually evaluate, adapt, and refine those materials. (Stevens et al., 2008, p. 196)

The LOGO Project took place throughout the 2005-2006 school year and the summer following. Several seventh grade math teachers participated in a total of 36 hours of in-service training, in which teachers learned how to use LOGO software to teach geometry. The workshop instructors focused on the content as well as its delivery. The methods of delivery were carefully chosen to support teachers' self-sufficiency and proficiency, which the instructors assessed throughout the project (Stevens et al., 2008).

Throughout the LOGO Project, teachers learned by working together, while Project instructors were there to provide guided discovery (Stevens et al., 2008).

> Results reveal that increases in LOGO self-efficacy and self-determination can be achieved when workshop instructors encourage choices, promote individuals' agency, and are available across time. This strategy appears to encourage teachers' implementation of new technological skills into classrooms and resiliency when confronted with obstacles to this process. (Stevens et al., 2008, p. 195)

In another study, a mathematics middle school teacher participated in 15-weeks of training from InterMath, a professional development program (Glazer, 2004). Through

this program, teachers learned mathematics though various forms of technology. Following her participation in InterMath, the teacher received eight weeks of assistance to integrate what she learned into her classroom. “Some teachers need to obtain additional support so they can independently implement technology-enhanced mathematical investigations in their own classroom” (Glazer, 2004, p. 117).

The goal of the study was for an expert to work with the novice mathematics teacher until the teacher was self-sufficient. The study also examined the factors that would help the teacher feel empowered to integrate technology in her classroom. For the first two weeks of the study, the expert played a significant role in helping the teacher design and use lessons with technology. The expert also offered assistance to the students and within the classroom, while the lessons were being taught (Glazer, 2004).

The expert’s role in the design and implementation of technology gradually faded throughout the remaining six weeks, until the teacher was fully designing and implementing the lessons on her own. During the last two weeks, the expert functioned mainly as an observer (Glazer, 2004).

“Needs awareness, autonomy, and confidence are three primary components that have influenced the teacher in this study to design, develop, and implement technology-enhanced activities” (Glazer, 2004, p. 125). Throughout the eight weeks of working with the expert, the teacher recognized her needs and learned how she can use coworkers, the internet, and other resources to meet her needs. By the end of the study, the teacher demonstrated that she could independently “design, develop, and implement technology-enhanced activities” (Glazer, 2004, p. 125). The teacher also had more confidence to

implement technology as she used it more and became more familiar with various technological tools.

The study found that having an expert help the teacher for the eight week period of time was successful. In one instance in her classroom, a student pointed out that she had made a mistake on a template she had given to her students. She was able to calmly fix the error and then have students change theirs as well. Before receiving technology training, she would have panicked if such a situation would have arisen. The teacher was amazed at the level of comfort she now experienced with technology. The following semester, this teacher also began to teach colleagues how to integrate technology into their classroom.

Chapter 3: Interpretation

Effectiveness of Technology in Middle School Mathematics

Based on the research, the author has concluded that using technology can be very beneficial, even necessary, in the middle school mathematics classroom.

The author will now refer to the same specific examples of technology she did at the beginning of chapter two and give a few reasons why those examples can be useful in a middle school mathematics classroom.

- *Clickers* provide immediate feedback, which can help teachers instantly assess if, and which, students may be struggling. This helps students learn mathematics because teachers can use clickers any time during in a lesson, allowing teachers to gauge if students understand the material. Clickers can also be useful for accountability. For example, teachers can have students type in their answers to homework questions; in order to receive their homework grade, it must be complete.
- An *interactive whiteboard* allows teachers to be away from their computer while having access to everything they can locate on the computer. It allows teachers to utilize numerous creative lessons that have been made specifically for an interactive whiteboard. Not only does the teacher use the interactive whiteboard, but it is an effective tool for students to use as well.
- Various software and multimedia-based packages can provide fun, interesting ways for students to learn mathematics, sometimes without them even realizing that they are learning. The *Fractions at Work* and *Fraction of the Cost* packages, for example, provide means by which students can measure

and cut pieces of skateboard ramps, then have three-dimensional views to check if their measurements worked out and their pieces fit together. Many math skills can be utilized in a single lesson.

- Computers, or laptops, allow students to access spreadsheets, lessons or tools online, word documents, software packages, etc. Students may also have access to a three dimensional view of something without needing the actual object. For example, students can create a virtual skateboard park, rather than a real one. Schools do not have to provide the actual supplies nor worry about safety issues.
- Various calculators, including graphing calculators, can be used as a tool to help students explore mathematics topics. For example, students could plot the graph of a line, then literally see how the graph changes as they change the slope of the equation. Many mathematics lessons and activities using certain calculators are available online.

Research studies continue to show that technology can be very effective when teaching mathematics. In the authors' review of literature, not one research study concluded that technology, when used in a proper manner, was harmful to student learning.

One major theme that evolved throughout the literature review was that students enjoyed learning using technology. One might argue that learning is not all about fun. However, if students are disinterested, they are not going to learn much.

Preparation Pre-Service Teachers Receive with Respect to Technology

Based on the research, pre-service mathematics' teachers have typically been required to take a course or two regarding technology. This was not sufficient for numerous reasons. Pre-service teachers were not given enough practice to use technology to teach mathematics or even given exposure to numerous forms of technology available. Once in the field, mathematics teachers were expected to incorporate technology on a frequent basis, while technology was not part of most of their pre-service courses.

Pre-service teachers also felt that they did not receive enough practice using technology during their student teaching experiences. In some instances, the cooperating teacher did not use much technology while teaching mathematics. In other cases, the cooperating teacher used technology while teaching but failed to require the student teacher to use it.

This is, however, a problem that many pre-service institutions are recognizing, and new plans, such as the one by (Smart Technologies, Inc., 2011) Arizona State University (Brush et al., 2002), are being made to incorporate more technology during the student teaching process.

Effective Trainings for Teachers to Implement Technology

Numerous forms of in-services, workshops, trainings, etc are available for in-service teachers. The author will discuss various forms of training as well as their effectiveness in this section.

Though some mathematics classrooms have access to many forms of technology, research has shown that many teachers do not feel equipped to use it effectively. It appears that single-day workshops, in which the teachers learn about a particular piece of

technology, are not especially effective in helping teachers teach mathematics using technology. These workshops may not include one or more of the following: specifically addressing mathematics, follow-up, or hands-on practice with the technology. The training may also focus on how to use that piece of technology rather than how to teach mathematics while using that particular technology as a tool.

In an ideal training setting, in which the goal would be that teachers eventually successfully teach mathematics using technology, the content would focus specifically on teaching mathematics while using one or more means of technology. A series of training sessions would occur over a span of time, such as a school year. During the training sessions, teachers would be able to practice using the technology, create lessons (thus promoting a sense of ownership), and perhaps even present pieces of their lesson to their colleagues. Having various training sessions over a span of time would provide accountability for teachers as well as a continued forum for discussion as they implement technology. Teachers would be given time to become comfortable with the technology and grow in confidence. Additionally, it would be beneficial to have a trainer, or an experienced coworker, available to work with the mathematics teacher within the classroom.

Due to time, finances, etc, it is not always possible to create an ideal, ongoing training setting. However, it is valuable to include as many of the elements in the above paragraphs as possible. For example, if it is not feasible to let teachers create or present a lesson, at least having teachers “try out” the technology is necessary and beneficial. It is also advantageous for the mathematics teacher to participate as a student while the trainer presents a lesson.

Chapter 4: Conclusion

Details about the Author's Classroom

The author teaches in a small town in Northwestern Minnesota. She currently teaches mathematics for grades 7-12 in a building that houses approximately 160 Pre-K through 12th grade students. Seventh Grade Math, Pre-Algebra, Algebra, Algebra II, Basic Geometry, Geometry, Senior Math, and College Algebra are courses the author has taught. She also previously taught 5th and 6th grade mathematics. The author has been a mathematics teacher for five years.

The author's classes typically have ten or fewer students. Most of the student body is Caucasian with a small percentage of Hispanics. The author's school is considered a Title One school, in which most of the students receive free or reduced lunch.

Current Technology Use of the Author

The author uses an interactive whiteboard, specifically a Smartboard, in her classroom every day. Here are a few ways in which the author uses the interactive whiteboard:

- *Notes...*The author frequently provides printouts of example problems for her students. The interactive whiteboard allows the author to easily save all problems in advance and simply click to get to the next problem. The author can save everything that is written on the interactive whiteboard and print it out for students who are absent. Any time while taking notes, the author can easily access another software program or internet site.

- *Lessons/activities available online*…Numerous mathematics lessons are available online. In addition to the websites mentioned in the Review of Literature, the author occasionally uses mathematics lessons provided through http://www.smarttech.com (Smart Technologies, Inc, 2011). Students in the author's classroom particularly enjoy the measuring angles activity found at http://www.oswego.org/ocsd-web/games/bananahunt/bhunt.html. During this activity and numerous others, students use the interactive whiteboard.
- *Smartboard software* (Smart Technologies, Inc, 2011)...The Smartboard package includes many math tools such as interactive math tools protractors, number cubes, coins, etc. While teaching probability units, for example, the author frequently uses number cubes and coins.

The author's school has approximately thirty laptops available for student use as well as a computer lab in which a few computers are usually available. Throughout the past school year, the author had students access various mathematics websites. Students typically had a particular site, or software program, to go to complete a task. When finished, students had a list of other sites they could visit which provided mathematics games or activities. Students enjoyed the activities so much sometimes that they would voluntarily access them at home, too.

Findings Regarding Using Technology

The author chose "Technology in the Middle School Mathematics Classroom" as the topic for this research paper because, along with colleagues and research findings, the author has often felt inadequate and overwhelmed regarding technology. Technology

available for mathematics classrooms is limitless, yet teachers, including the author, often feel strapped for time.

However, as the research showed, it is necessary to implement technology. After doing this research paper, the author has found that it is worthwhile to implement whatever technology she can. It would be impossible to learn how to teach mathematics using all forms of technology available, but it might be possible to schedule a couple of hours one night per week to explore more technology. During one week, the author could explore math websites available, the next she could explore more of the tools available through Smartboard software, etc. Though using technology perfectly in a mathematics classroom is a goal that can never be attained, the author has found that a better objective is simply to make progress, implementing a little bit more technology each year.

Technology Goals for the Author

Especially for teaching in a relatively small school, the author feels very fortunate to have access to many forms of technology. After researching for this paper, one of the author's main goals is: "Utilize the technology that is available to me."

The author uses graphing calculators occasionally in her high school classes and typically allows middle school classes to use non-graphing, scientific calculators. The author would like to allow her middle school classes to use graphing calculators occasionally this next school year. The research showed that in content areas such as linear algebra, graphing calculators can be extremely beneficial to student learning.

One of the first things the author plans to do as she prepares for this next school year is set up "Clickers." Clickers are available in the author's school, but she has not yet

utilized them. The author has contacted a coworker who is willing to help her set up clickers in her classroom.

After researching for this paper, the author desires to aid others regarding technology as well. The author will be available to help colleagues with the technology she knows how to use. She will also encourage colleagues to make small, steady strides using technology, rather than focusing on how much there is yet to learn.

Technology Trainings the Author Experienced

The author felt that her experience as a pre-service teacher was similar to those in the Review of Literature. A couple of her pre-service courses included elements of technology, but she was not taught ways in which to teach mathematics using technology. During her student teaching experience in 2006, in an eighth grade classroom, students used computers in a computer lab one day per week for a football project for approximately six weeks. Students utilized various websites (not specific to mathematics), spreadsheets, and word documents. Within the classroom, the few forms of technology available were typically not used. The students were not allowed to use any forms of technology, including calculators.

Currently, as an in-service teacher, the author is occasionally able to attend day- or two day- workshops, some of which include elements of technology. The author agrees that there is a gap between learning about the technology and learning how to utilize technology in the mathematics classroom, much less how to teach mathematics *through* technology. It seems to become the teacher's responsibility to figure out how various technologies might be used in their classroom.

Findings Regarding Technology Trainings

The author believes that having the ideal technology training setting, described in chapter three would, indeed, be extremely beneficial.

While taking courses at Bemidji State University, the author has learned teaching methods which help middle school students discover and understand mathematics. As part of the course expectations, the author has developed lessons using those methods and has presented portions of those lessons to her colleagues. Then, teachers are able to implement those lessons the following school year.

By requiring us to create lessons, we take ownership in working with these new methods and we leave the professional development having ready-to-use lesson plans. By presenting our lessons to our colleagues, we gain confidence in our ability to implement these new methods and we are able to share ideas in a group setting. Though many of these lessons have not specifically been about implementing technology, I can see how these effective ways would translate to "Teaching Mathematics through Technology" trainings, just as the research showed.

Call for More Research

The author would like to view more research regarding the use of technology in the middle school mathematics classroom. She would also like to see studies conducted on additional effective training programs available as well as how to get more teachers involved in those trainings. Additionally, she would like to see research conducted on programs available for teachers to help their coworkers implement technology.

References

Beeland, J. W. (2002). *Student engagement, visual learning and technology: Can interactive whiteboards help?* Retrieved November 3, 2010, from http://chiron.valdosta.edu/are/Artmanscrpt/vol1no1/beeland_am.pdf

Blubaugh, W. L. (2009, Winter). A course for pre-service teahers that focuses on mathematics and the integration of technology. *Mathematics and Computer Education*, 41-47.

Bottege, B. A., Grant, T. S., Stephens, A. C., & Rueda, E. (2010). Advancing the math skills of middle school students in technology education classrooms. *NASSP Bulliten, 94*(2), 81-106.

Browning, C., & Garza-Kling, G. (2010). Graphing calculators as tools. *Mathematics Teaching in the Middle School*, 480-485.

Brush, T., Igoe, A., Brinkerhoff, J., Glazewski, K., Ku, H.-Y., & Smith, T. (2002). Lessons from the field: Integrating technology into pre-service education. *Journal of Computing in Teacher Education, 17*(4), 3-17.

Education Development Center, Inc. (2003). *The Maine learning technology initiative: Technology-enhanced middle school mathematics.* Retrieved June 29, 2011, from http://www.edc.org/newsroom/articles/maine_ learning_technology_initiative

Glazer, E. (2004). From a caterpillar to a butterfly: The growth of a teacher in developing technology-enhanced mathematical investigations. *Journal of Technology and Teacher Education, 12*(1), 115-138.

Grabe, M., &. Grabe, C. (1998). *Integrating technology for meaningful learning* (2nd ed.). Boston: Houghton Mifflin.

Hardy, M. (2008). It's TIME for technology: The technology in mathematics education project. *Journal of Computers in Mathematics and Science Teaching*, 221-237.

Hollenbeck, R., & Fey, J. (2009). Technology and mathematics in the middle grades. *Mathematics Teaching in the Middle School, 14*(7), 430-435.

Jarrett, D. (1998, June 1). *Integrating technology into middle school mathematics: It's just good teaching*. Northwest Regional Educational Laboratory. Retrieved January 12, 201,1 from http://www.nwrel.org/msec/book6.pdf

Jones, C. (2001). Tech support: Preparing teachers to use technology. *Principal Leadership, 1*(9), 35-39.

Margaritis, A. (2003). Using graphing calculators in the montessori middle school classroom. *Montessori Life, 15*(2), 42-43.

Matassa, M. (2006, March/April). *Just a click away: Boulder Valley School District piloted student-response systems and proved the tools could enhance learning.* Retrieved July 2, 2011, from Ed Tech: http://www.edtechmag.com/k12/issues/march-april-2006/pilot-prove.html

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of Research on Technology in Education, 40*(4), 447-472.

National Counctil for Accreditation of Teacher Education (NCATE). (1997). *Technology and the new professional teacher: Preparing for the 21st century classroom.* Retrieved July 30, 2010, from National Council for Accreditation of Teacher Education: http://www.ncate.org/states/technology21.asp?ch=113

National Council of Teacher of Mathematics. (n.d.). *Activities*. Retrieved June 19, 2011, from NCTM Illuminations: http://illuminations.nctm.org/Activities.aspx?grade=3

Phillips-Bey, C. K. (2004). TI-73 Calculator Activities. *Mathematics Teaching in the Middle School*, 500-505.

Pope, M. H. (2002). Technology integration: Closing the gap between what preservice teachers are taught to do and what they can do. *Journal of Technology and Teacher Education*, 191-203.

Roschell, J., Shechtman, N., Tatar, D., Hegedus, S., Hopkins, B., Empson, S., et al. (2010). Integration of technology, curriculum, and professional development for advancing middle school mathematics: Three large-scale studies. *American Educational Research Journal*, 833-878.

Smart Technologies, Inc. (2001). *SMART notebook collaborative learning software*. Retrieved August 19, 2011, from Smart Technologies: http://www.smarttech.com/us/Solutions/Higher+Education+Solutions/Products+for+higher+education/Software/SMART+Notebook+collaborative+learning+software/SMART+Notebook+collaborative+learning+software

Smith, K., & Shotsberger, P. (2001). *Web-based teacher education: Improving communicatoin and professional knowledge in preservice and inservice teacher training.* (ERIC Document Reproduction Service No ED459161).

Stevens, T., To, Y., Harris, G., & Dwyer, J. (2008). The LOGO project: Designing an effective continuing education program for teachers. *Journal of Computers in Mathematics and Science Teaching*, 195-219.

Swan, B., & Dixon, J. (2006). *The effects of mentor-supported technology professional development on middle school mathematics teachers' attitudes and practice.* Retrieved July 21, 2010, from Contemporary Issues in Technology and Teacher Education: http://www.citejournal.org/vo16.iss1/mathematics/article1.cfm

Texas Instruments. (2011). *TI-73 Explorer: Features summary*. Retrieved July 2, 2011, from Texas Instruments: http://education.ti.com/educationportal/sites/US/productDetail/us_ti73.html

U.S.Department of Education. (2000). *E-Learning: Putting a world-class education at the fingertips of all children. The national educational technology plan.* Jessup, MD: Ed Pubs. (ERIC Document Reproduction Service No ED444604).