TEACHER PERCEPTIONS OF THE USE OF ONE-TO-ONE TECHNOLOGY IN ALGEBRA 1 CLASSROOMS

A Record of Study

by

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ABSTRACT

The purpose of this study was to analyze how self-efficacy interacts with technology integration in Algebra 1 classrooms. A case study approach was used to discover how technology was integrated into Algebra 1 classrooms in a comprehensive high school. The findings were analyzed based on the teachers' locus of control to understand how the efficacy of teachers impacted the technology integration.

The findings show the overall usage of technology was low, even after seven years of implementation of 1:1 computing in the high school. Teachers report usage is low due to lack of professional development that was subject specific and a lack of resources specific to Algebra 1. Teachers reported that barriers in place, including outdated grading policies and negative student behaviors, were outside of their locus of control.

In order to increase the efficacy of teachers in using technology tools in Algebra 1, specific professional development could be utilized to ensure teachers are successful with initial implementation. Resources that integrate Algebra 1 content on computers should be written into curriculum documents to allow teachers time to collaborate rather than find resources. Professional Learning Communities (PLC) should also be utilized to help teachers share mastery and vicarious experiences which may increase their efficacy towards utilizing technology for meaningful mathematics instruction.

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NOMENCLATURE

1:1	One-to-one student to computer ratio
CCSS	Common Core State Standards
IRB	Institutional Review Board
NCLB	No Child Left Behind
NCTM	National Council of Teachers of Mathematics
PLC	Professional Learning Community
Tablet PC	Convertible touch-screen tablet personal computer

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CHAPTER I

INTRODUCTION

Technology tools have become ubiquitous in secondary education in recent years as more access and lower prices make school-wide equity possible (Monke, 2006). An understanding of how teachers use technology tools to strengthen student understanding is key in implementation, training, and ensuring student success in an era of accountability (Warschauer, 2006). Particularly in Algebra 1 classrooms, teachers face a multitude of district and state mandates surrounding curriculum materials, delivery, and assessment that guides the learning process in either a positive or negative direction based on their understanding of student knowledge of mathematics. As Algebra 1 teachers utilize technology tools in the classroom, it is important they understand how to leverage the technology for student understanding. This topic is especially important as Algebra 1 is often considered a gateway course, in which a solid student foundation is important for future learning in high school and college mathematics (Spielhagen, 2006). It is important research analyzes how teachers' perceptions of using technology foster student success in Algebra 1 (Ertmer & Ottenbreit-Leftwich, 2010).

In recent years, more secondary schools have adopted one-to-one (1:1) student-to-computer ratios in high school (Dunleavy & Heinecke, 2008; Fadel & Lemke, 2006). This ratio ensures all students have the same computer device they can use both inside and outside of school. Students can use these devices to access information and complete assignments. This influx of technology is new for teachers, who for the most part learned in technology-free environments.

Within the Algebra 1 classroom, self-efficacy of mathematics proficiency has been shown to have a determining effect on student and teacher success (Fast et al., 2010). Teachers who feel they have the tools and skills necessary to be successful in teaching math typically have students who are outperforming their peers (Bandura, 1977). This would mean it is important technology tools do not inhibit teacher understanding of their own efficacy beliefs (Fast et al., 2010). By understanding how teachers utilize technology in the math classroom, research can show how teachers can integrate technology tools to help students understand deep mathematical content (Paraskeva, Bouta, & Papagianni, 2008).

Technology integration impacts the types of instructional strategies needed when computers or other technology tools are added to high school math classes (Fast et al., 2010). Teachers have opportunities to present material and interact with students in new ways. When teachers feel they have the tools and training necessary to implement the technology programs, then productive instructional strategies and student achievement are more likely to increase (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). The collective efficacy of teacher groups also plays a role as teachers plan in Professional Learning Communities (PLCs) and work together to implement new instructional strategies that can be used to integrate technology tools (Bandura, 1997).

Problem Statement

The literature regarding technology usage shows a benefit from technology integration. Technology tools provide for engagement of students and the ability for students to visualize and communicate about mathematics in a new way (Silk, Higashi, Shoop, & Schunn, 2010). In order for the positive benefits to be realized, professional development into the technology tools and a new pedagogical method are critical aspects of pre-service and in-service teacher training (Ertmer & Ottenbreit-Leftwich, 2010).

Understanding how teachers' self-efficacy towards technology interacts with their confidence is a topic where more research is needed (Ertmer & Ottenbreit-Leftwich, 2010; Warschauer, 2006). If teachers believe they have the skills necessary to use technology in a meaningful way, then the use of meaningful technology activities should be aligned with greater engagement in tasks and greater understanding of mathematical concepts (Morris & Thrasher, 2009). A gap exists in the literature with regard to research in the interaction among technology self-efficacy, math self-efficacy, and teacher confidence. Although several studies show the effects of self-efficacy on math instruction and learning, little has been done to relate the self-efficacy of technology use to the mathematics classroom (Fast et al., 2010; Wilfong, 2006). The research on classroom use of technology focuses on web-based instruction rather than a 1:1 classroom environment (Van Gundy, Morton, Liu, & Kline, 2006). By understanding these interactions, teachers would be better equipped to leverage technology as a meaningful instructional tool in mathematics.

Because of the increase in use of technology tools, we need to determine factors that influence teachers' perceptions of their ability to use technology tools in classrooms with students. Factors that negatively impact the efficacy of teachers using technology for instruction should be identified in order to provide for a positive teaching and learning environment. Factors that positively influence teacher efficacy should be identified so procedures and training can be put in place to support teachers in the classroom.

Research Objective

In order to identify influences that impact teacher efficacy towards technology, this study analyzed qualitative data using a framework identified by Guskey and Passaro (1994). The framework categorizes efficacy factors into four broad categories that identify both personal and external factors: personal-internal, personal-external, teaching-internal, and teaching-external. Teacher efficacy in using technology tools for instruction can be difficult to measure because it is often concept specific (Guskey & Passaro, 1994). Teachers might feel comfortable and confident teaching a specific lesson, but using a technology integrated instructional strategy may affect feelings of efficacy. Bandura (1977) specifically addressed teacher efficacy in his research and found teachers are more likely to put forth effort, persist in the face of obstacles, and experience less stress when there is a high level of efficacy in their work. Teacher efficacy can be a useful construct in understanding the complex interactions between the teachers' feelings of confidence in conceptual understanding, instructional tools, and student abilities (Tschannen-Moran et al., 1998).

Research Questions

The research questions for this dissertation focused on the in-service Algebra 1 teachers' perceptions of their ability to use technology tools in a 1:1 environment to enhance their classroom instruction and assist students with building mathematical proficiency. By asking questions to understand teacher efficacy towards mathematics instruction using technology tools, this dissertation had a goal of finding information teachers could use to leverage technology tools in the classroom to build student understanding of mathematical concepts and build instructional confidence in using technology tools. More specifically:

1) What factors, both internal and external, influence teacher efficacy towards using technology tools in math classrooms?
2) What can administrators and teachers do in order to build teacher efficacy toward instructional effectiveness?

Design and Overview of the Study

This dissertation utilized qualitative case study research in order to uncover teacher perceptions and use of technology tools in a 1:1 environment (Schwandt, 2007). Three in-service Algebra 1 teachers and their supervising administrator were involved as participants in the study. The participants were chosen using purposeful sampling to ensure a cross section of participants in regard to years of teaching experience and level of comfort in using technology for instructional purposes. Data collection occurred in the spring semester of 2015. The data collected consisted of semi-structured interviews, classroom observations, and artifacts related to the study. Artifacts included teacher lesson plans, records of teacher professional development, and notes from teacher planning sessions.

The data was analyzed according to an a priori theory including the self-efficacy framework developed by Guskey and Passaro (1994). Their framework analyzes self-efficacy variables with regard to locus of control of the teacher as they relate to their confidence and efficacy in using instructional practices. Grounded theory was used to determine subthemes that could then be used to describe the self-efficacy of teachers in the study (Creswell, 2007). Subthemes for analysis were grounded in the set of data derived directly from the interviews. The benefit to using a grounded interpretational analysis is the ability to achieve insights from the qualitative data that may not be initially apparent (Creswell, 2007).

Summary

Chapter I provided a rationale for the study by focusing on self-efficacy towards mathematical tasks as an important component in ensuring students have the tools necessary to be successful in an educational system focused on accountability and high-stakes testing for Algebra 1 students. Also provided in Chapter I was a brief discussion on the methodology involved in the study. Chapter II provides a detailed review of literature that focuses on the history of technology tools in high school mathematics and the increased usage of technology in 1:1 student-to-computer ratio environments. The review of literature also provides a review of self-efficacy research as it is relates to the theoretical framework surrounding the eventual findings and recommendations for how technology tools can be leveraged in a 1:1 environment. Chapter III provides details of the research methodology used in the study as well as a description of the data sources, collection, and analysis procedures. Chapter IV explains the results of the study including data from interviews and observations and connects those results to the self-efficacy domains that impact student learning. Chapter V provides a summary and discussion of recommendations for practice and future research.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study is to study the impact of self-efficacy on teacher use of technology tools, specifically 1:1 technology, in Algebra 1 classrooms. This literature review, which focuses on understanding use of technology and related self-efficacy concepts in secondary math classrooms, begins with a section on the history of technology usage in mathematics. The second section will explain how abstract mathematical concepts cause Algebra 1 to be a gateway course in high school. Next, student engagement concepts will be studied to see how engagement in math inquiry can break barriers to abstract mathematics. Self-efficacy will be defined with regards to math and technology, with an analysis of studies that show self-efficacy can improve math achievement. Finally, specific technology tools will be addressed, with a focus on 1:1 computing programs that require further research.

History of Technology Integration in Mathematics

In 2000 the National Council of Teachers of Mathematics (NCTM) released their list of *Principles and Standards for School Mathematics*. The NCTM laid out a vision in this book for what mathematics instruction should look and feel like as teachers and students entered the 21st century. Through these principles that guide K-12 mathematics instruction, the NCTM has led the way for state and district leaders as well as teachers to engage in more meaningful curriculum, instruction, and assessment for the nation's students. One of the more forward-thinking principles outlined in the book is "The

Technology Principle," which guides teachers in engaging students through instruction using effective technology tools and pedagogy.

As more schools and teachers embed technology tools into their daily instructional practices, the need for pedagogical change is apparent as teachers move from a classroom centered on paper and pencil to a classroom centered on a laptop and graphing calculator. Teacher training is a key component of technology integration in order for students to truly engage with and explore mathematics through the technology tools, instead of the tools becoming a novelty (Ertmer & Ottenbreit-Leftwich, 2010). As researchers continue to analyze technology and its ability to engage students in mathematics, the literature has focused on whether or not technology has brought about substantial changes in mathematics achievement and efficacy. Teachers need pedagogical assistance in how to embed appropriate technology tools in the math classroom if technology is to be used in a truly engaging manner (Warschauer, 2006).

A theme throughout the NCTM's standards is the use of engagement and communication to assist students with a deeper understanding of mathematical content (NCTM, 2000). Student communication and engagement can lead to a higher level of understanding of abstract mathematics and a higher sense of self-efficacy for students (Morris & Thrasher, 2009). Because of the varying technology tools available for teachers, the literature includes studies that incorporate a number of tools: including graphing calculators, student response systems, interactive whiteboards, computer software, and schools with a 1:1 student to computer ratio. A recurring theme in the literature since the NCTM published "The Technology Principle," is student engagement in mathematics learning tasks is increased through the proper use of technology tools (Ertmer & Ottenbreit-Leftwich, 2010; Fadel & Lemke, 2006).

Although technology tools such as calculators and computers have been used in instructional capacities for over 30 years, the use of such tools is still controversial in middle school and high school math classrooms (Ertmer & Ottenbreit-Leftwich, 2010). As technology tools have become more commonplace in general society, teachers tend to see calculators and computers can be beneficial instructional tools, but they often lack the knowledge of how to incorporate the tools into the classroom (Guerrero, Walker, & Dugdale, 2004). This is in contrast to a Third International Mathematics and Science Study (TIMSS) which showed middle school students from countries that used calculators more in the classroom tended to score lower on tests of basic math skills (Tarr, Uekawa, Mittag, & Lennex, 2000). These findings suggest more information and research is needed to understand how and when technology tools should be used in math classrooms.

Principles and standards

Given that this study examines how technology integrates with the teaching of Algebra 1, it is important to understand the role the NCTM plays in setting standards and policy for math teachers. The NCTM is a professional group of teachers of mathematics who represent math teachers and administrators from across the United States. This group works with policymakers to ensure rigorous, age-appropriate mathematics standards and policies are in place at the federal and state levels. The NCTM also sets goals for mathematics instruction with regards to access, equity, accountability, and technology usage.

In 2000, the NCTM published its list of six principles for school mathematics. These six standards: Equity, Curriculum, Teaching, Learning, Assessment, and Technology, have guided national, state, and local decisions for mathematics for more than a decade (Common Core State Standards Initiative, 2010). As state and federal accountability systems have addressed the need for higher scores for all student populations on math assessments, the Equity Principle which addresses the need for high expectations and strong support for all students is used as an example of how educational organizations are calling for higher accountability standards (Aspen Institute, 2007). The principles of Curriculum, Teaching, Learning, and Assessment guide math teachers as to how a coherent curriculum along with thoughtful instructional practices can be used to support students (NCTM, 2000). Throughout the other areas, the Technology Principle addresses how not only access to technology tools, but also how their appropriate usage can influence the mathematics taught and can enhance student learning (NCTM, 2000).

The NCTM (2000) also addresses standards, or what mathematics concepts are to be taught throughout different grade bands in elementary, middle, and high school. By having a coherent vertical alignment provided by the NCTM, states and federal educational groups have been able to create specific learning standards for students that guide them through early elementary to high school mathematics. Having a clear vertical alignment is a major factor in student success, especially as students move from middle school mathematics to Algebra 1 (Stinson, 2004). However, simply having a clear vertical alignment is not enough to ensure students will have the tools and knowledge ready to transition from the concrete mathematics in middle school to the abstract mathematics in Algebra 1. Stinson (2004) suggests Algebra 1 has unfortunately become a gatekeeper to higher-level mathematics. If students do not have a clear understanding and a strong foundation in functions from Algebra 1, they are not prepared to face the higher-level thinking needed to understand Algebra 2, precalculus, or calculus concepts (Day & Jones, 1997). Understanding the need for a strong Algebra 1 curriculum and support for students is an important step for math teachers and supervisors (Pillay, Wilss, & Boulton-Lewis, 1998).

Math curriculum standards continue to evolve in the 21st century with the development and adoption by many states of the Common Core State Standards (CCSS) for mathematics (Common Core State Standards Initiative, 2010). These curriculum standards differ from mathematics standards in the past because of the addition of numerical fluency, earlier mastery of basic skills, and integrated math process skills woven throughout the standards. As with any change in standards, adopting the CCSS might provide challenges for math teachers and students. Because of the increase in rigor and the addition of more upper-level math classes in high school, students will be faced with completing more advanced math classes than students in the past (Reys & Reys, 2011). The change to CCSS also aligns with a heightened sense of accountability for teachers and students in secondary school (Cawelti, 2006).

Accountability

An increased focus on accountability for teachers and schools to teach all students a coherent and challenging curriculum is exemplified by No Child Left Behind (NCLB) legislation (Aspen Institute, 2007). This legislation focuses on educational success for all students through testing that highlights what students do and do not know regarding reading and math education (Cawelti, 2006). The accountability standards put into place by NCLB align closely to the Equity Principle highlighted by the NCTM (2000). By focusing on all student groups and stressing supports for students who are not successful, NCLB and NCTM have a common goal to close the achievement gap between racial student groups while ensuring a chance for college readiness for all students.

The implementation of NCLB has had lasting effects on school mathematics, including positive and negative changes to what mathematics students learn and how they learn it (Cawelti, 2006). On a positive note, Schmidt (2004) suggests NCLB has forced states to adopt a coherent and challenging curriculum for students in elementary and middle schools, therefore changing what mathematics students learn at specific ages. This change in curriculum aligns the United States with other nations that have higher scores on the TIMSS (Tarr et al., 2000). Although teacher preparation and pedagogy are important factors in student achievement, Schmidt (2004) feels curricular changes in mathematics are initial steps in ensuring students are challenged at appropriate levels of rigor.

Negative effects of NCLB legislation might be seen in the types of classroom activities teachers ask students to complete. Because of the focus on high stakes testing by school districts and teachers, there can be a narrowing of the curriculum; ensuring students are prepared for a test while neglecting other important concepts (Cawelti, 2006). Although teachers reported testing should not be the sole focus of math education, Cawelti (2006) found teachers responded to external pressure to increase student achievement scores. These teachers felt they resorted to test preparation activities, such as extensive worksheet practice and memorizing test-taking strategies, instead of higher level mathematics concepts teachers felt were more important (Cawelti, 2006).

In an attempt to close the achievement gap, NCLB addresses teacher preparedness by requiring teachers to be highly qualified by being certified to teach in their subject area (Aspen Institute, 2007). However, being highly qualified in and of itself does not ensure teachers are prepared to teach an increasingly challenging curriculum and prepare students for high stakes testing (T. M. Smith, Desimone, & Ueno, 2005). School district leaders should ensure teachers are provided with ongoing professional development opportunities to learn how to provide an enriching classroom environment (Becker, 1994; Ertmer & Ottenbreit-Leftwich, 2010; Warschauer, 2006). Smith et al. (2005) suggest a combination of highly qualified educators and ongoing professional development opportunities will ensure teachers are prepared to meet the demands of NCLB.

Active engagement in mathematics and how it relates to student achievement scores was a focus of The National Research Council's Committee on Increasing High School Students' Engagement and Motivation to Learn (2004). The committee suggests active engagement in mathematics, such as communication and authentic problem solving, is a key factor for student learning and success. Therefore, finding ways for students to be engaged in mathematics courses can be an important aspect of math teachers' pedagogical practices. By encouraging students to learn in modalities that are a common aspect of their social lives, engagement in the classroom becomes a natural part of the instructional process (Ertmer & Ottenbreit-Leftwich, 2010). Integrating technology tools into the math classroom therefore may become a natural part of encouraging students to become more involved in their own learning.

Technology tools

Teachers in the 21st century classroom have a diverse selection of technology tools to use with their students, such as: calculators, computers, student response systems, or interactive whiteboards (Ertmer & Ottenbreit-Leftwich, 2010; Guerrero et al., 2004). The first technology tools to make their way into the classroom were handheld calculators (NCTM, 2000). Starting as early as the 1970s and 1980s, teachers began to use simple four-function calculators in the classroom (Fadel & Lemke, 2006). In the 1990s, the advent of the graphing calculator meant teachers had a new tool students in high school could use to model multiple representations and visualize abstract mathematical concepts (Ozel, Yetkiner, & Capraro, 2008).

The use of calculators in math classrooms was not immediately accepted by many math teachers (Cuban, Kirkpatrick, & Peck, 2001). Teachers felt students were able to use the calculators to complete too much arithmetic, taking away the skill practice that was the central mode of instruction at the time (Cuban et al., 2001). Even the NCTM addressed calculator usage in the 1980s by suggesting teachers needed to limit the amount of time students were able to use the tools (NCTM, 2000). Over the years however, calculator usage has become more widespread as teachers have learned new ways to use the tools and use them in different ways (Cuban et al., 2001). As calculators have been required on state and national assessment exams, their acceptance for instructional use in the classroom has also been improved (Ertmer & Ottenbreit-Leftwich, 2010).

The acceptance and use of computers in the classroom followed much of the same history of the calculator. At first, computer use in the math classroom was not accepted, either because access to sufficient numbers of computers was not available or because there were not sufficient software programs available to address mathematics concepts (Cuban et al., 2001). The increased use of computers outside of school, the use of the internet to provide access to information, and the lower cost of computers have allowed teachers to use computers more in the math classrooms, making a large increase in the 2000s (Becker, 2000; Ozel et al., 2008). An important factor in how computers are used in the classroom to increase student achievement is whether or not teachers have sufficient professional development in using technology in an instructional setting (Warschauer, 2006).

Student response systems are a more recent tool teachers can use for formative assessment and to engage students in new ways (Fadel & Lemke, 2006). These small, handheld response pads are used by students to submit answers via wireless networks to the teacher computer (King & Robinson, 2009). The teacher might then use the formative assessment data to modify instructional strategies or give students an idea of what they do or do not understand about mathematical concepts (Chappuis, 2009). The use of student response systems can be a powerful instructional strategy. They allow for heightened student engagement because all students are required to enter a response, and students are able to enter their answer anonymously, therefore reducing student anxiety towards providing an incorrect answer (King & Robinson, 2009).

Interactive whiteboards, used most often as a teacher presentation tool, can provide a new avenue for students to visualize abstract mathematical concepts (Fadel & Lemke, 2006). The teacher or students can use the interactive whiteboard to present or demonstrate mathematical concepts using virtual manipulatives or mathematical modeling tools (Bos, 2009). By taking the information previously only visible on a small computer screen, and making it larger so all students can see, the interactive whiteboard has become a popular tool for teachers of all grade levels (Slay, Siebörger, & Hodgkinson-Williams, 2008). The most beneficial results from interactive whiteboards are seen when the students, not the teacher, are the individuals manipulating the information on the screen (H. J. Smith, Higgins, Wall, & Miller, 2005).

Abstract Mathematics

Solving problems that include abstract mathematical concepts can be challenging for many learners (Cavanagh, 2008; Day & Jones, 1997). As students progress through the primary grades, they work with concrete models, number sense, and algorithms for computation (Van de Walle, Karp, & Bay-Williams, 2010). When students enter Algebra 1, they are asked to solve problems in a much more abstract fashion, allowing for the use of variables and equations to represent real-world situations (Pillay et al., 1998). Part of the difficulty with learning abstract mathematics is the use of multiple representations (Van de Walle et al., 2010). This might include the use of graphs, tables, algebraic equations, and verbal descriptions to analyze mathematical situations. Technology tools such as graphing calculators, computers, and interactive whiteboards can be used by students to assist with the understanding of multiple representations (Guerrero et al., 2004).

Algebra readiness

In order for students to be successful in working with algebra concepts, they need to have strong number sense skills including concepts of operation and properties of numbers, specifically rational numbers (Baltus, 2010). These foundational skills are critical for students to be able to use when solving equations, graphing lines, and solving problems that require the combination of different mathematical strands (Stacey & MacGregor, 1997). As students work through rigorous mathematical tasks, the use of technology tools can allow students to access the higher-order thinking needed to solve the problems and have the discussions necessary to understand the mathematics concepts

(Pillay et al., 1998). As students work with rigorous problems, their understanding of the operation and properties of numbers will likely continue to improve.

As students progress through high school and college, a solid foundation in algebra skills has been found to be a key factor in student achievement (Burris, Heubert, & Levin, 2006). Success in a rigorous Algebra 1 course can be linked to students taking more advanced math courses in high school and enrollment in college (Spielhagen, 2006). Burris et al. (2006) found students who were enrolled in a rigorous Algebra 1 course incorporating the use of technology tools were more likely to enroll and excel in higher level mathematics courses such as calculus and statistics.

The change in thought process from concrete to abstract mathematics presents difficulty to students as they enter high school math courses (Day & Jones, 1997). Without proper support from the teacher, students might experience anxiety during this change in thought process (Cavanagh, 2008). In order to transition from concrete examples of fractions and proportions to abstract knowledge of fractions, visual representations are significant tools for the cognitive development of students (Baltus, 2010). Using visual representations such as tables, bar diagrams, and graphs can help students make the connections from concrete mathematics to abstract algebra (Van de Walle et al., 2010). Clearly, technology can be used as an effective method of providing visuals through the use of tables and graphs while allowing students to interact with data and make connections to real-world applications.

Manipulatives

In mathematics, concrete manipulatives are used to assist students with visualizing abstract mathematical ideas and make connections to prior learning (Van de Walle et al., 2010). Manipulatives come in many forms, including: base-ten blocks to model the base-ten number system, Cuisenaire rods to model fractions and proportional reasoning, geoboards to model 2-dimensional geometric concepts, and algebra tiles to model polynomials and algebraic equations (Van de Walle et al., 2010).

As more math classrooms integrate technology tools into daily instructional practices, virtual manipulatives have become a popular choice for classroom use (Spicer, 2000). Virtual manipulatives are either web-based applications or software loaded onto computers that allow students or the teacher to manipulate virtual objects for the purpose of constructing mathematical knowledge (Moyer, Bolyard, & Spikell, 2002). By having virtual manipulatives as an option in the classroom, the teacher can allow students to either use the concrete manipulatives or work at the computer on their math work. Moyer et al. (2002) suggest by using virtual manipulatives the teacher can solve the problem of not having enough of the concrete objects. Students may have access to the virtual manipulatives at home on a networked computer. The teacher should ensure the students have adequate access to computers in the classroom that will run the appropriate software needed to utilize the virtual manipulatives, so all students can take advantage of the virtual tools (Moyer et al., 2002).

Virtual manipulatives can be either static or dynamic images of concrete objects (Spicer, 2000). Static virtual manipulatives are pictures of objects students can count, discuss, or use as models, but they are not able to be moved. Dynamic virtual manipulatives can be moved by students using a mouse or stylus in order to rotate, flip, or change the virtual image in much the same way as a concrete manipulative. Moyer et al. (2002) suggest dynamic virtual manipulatives are more useful to teachers and students because of the versatility and the ability for students to change and manipulate the figures to construct mathematical models that will help with their understanding.

Using dynamic virtual manipulatives also assists with student creativity and engagement because students have a new avenue of sharing and presenting their mathematical thinking (Bellamy & Mativo, 2010). As students are asked to solve more complex problems in Algebra 1, Moyer et al. (2002) found students use more creative methods of solving math problems by showing their reasoning through a variety of visual representations. They also suggest technology tools such as a computer can increase student engagement through the fact students are using tools they are comfortable using at home.

Student Engagement

In order for students to internalize and understand abstract mathematics, engagement in the learning process is a key component of math instructional time (Van de Walle et al., 2010). Engagement in secondary math classes might take the form of students working with manipulatives, discussing or writing using academic math vocabulary, and using technology tools to assist with multiple representations (NCTM, 2000). Abbasi and Iqbal (2009) found students answered surveys of class engagement and satisfaction more favorably if they had math teachers who taught using concrete examples and made complex mathematical methods accessible through the use of technology.

Pedagogy

As teachers design mathematical tasks moving students from concrete to abstract mathematics, they should consider how students prefer to learn and discuss mathematics (Wolf, 2008). For many teachers, the primary resource used to gain insight into the types of examples and problems students should complete in class is a traditional textbook (Nathan & Koedinger, 2000). However, the textbooks many algebra teachers use do not always align with how students learn. In their analysis of textbook examples and student problem-solving, Nathan and Koedinger (2000) found algebra textbooks tend to use problems that assume students have mastered the prerequisites of equivalence and variables. The textbooks also include examples focused primarily on symbols and equations. However, by analyzing the problem-solving methods used by middle school students, Nathan and Koedinger (2000) found high school algebra students preferred to use a more verbal approach to solving algebraic problems by discussing the problems, either with peers or in writing, rather than using only an equation.

A math classroom that includes rigorous problem solving and reasoning should include opportunities for students to communicate their mathematical reasoning to both the teacher and to other students (NCTM, 2000). When students are asked to verbalize their reasoning and share their problem solving processes with others, the students internalize and have a deeper understanding of the mathematics (Van de Walle et al., 2010). Huang, Normandia, and Greer (2005) found in a study of middle school and high school math classrooms communication is related to understanding of mathematics and teachers should explicitly use the language of reasoning with their students. When mathematical discourse was absent, student engagement and understanding of math content was also absent (Huang et al., 2005).

Using technology tools such as presentation software to share their ideas assists students with communication and becoming verbally engaged in mathematical conversations (Becker, 2000). In a qualitative study of classrooms in grades four through twelve by Becker (2000), students were more likely to become engaged in mathematical conversations when they used presentation software to create and share speeches or discussions of their mathematical reasoning. Becker (2000) suggests communication and student engagement were increased using presentation software because as students use technology tools at home, they are comfortable using those same tools in school. By creating classroom activities and using resources students are comfortable with, Becker (2000) shows teachers can increase student engagement, communication, and therefore increase understanding of math content.

As technology becomes more pervasive in students' home lives, it is also becoming commonplace in the classroom (Fadel & Lemke, 2006). This integration of technology into students' lives has implications in the classroom as teachers search for activities including technology as an integrated part of the instruction rather than a separate activity (Hegedus & Kaput, 2004). Within the classroom social context, Hegedus and Kaput (2004) find when students work within collaborative groups using technology tools, communication and engagement are aligned with higher student understanding of algebra concepts. When students worked in collaborative groups on technology tasks embedded within the algebra concepts, students had a shared responsibility to be engaged in the task (Hegedus & Kaput, 2004). Student engagement was increased not only by the technology tools as a pervasive part of the students' lives, but also the collaborative nature of the communication among students (Hegedus & Kaput, 2004).

Instructional tools

Teachers can use several methods to make Algebra 1 and abstract mathematics more accessible for students. Technology is a tool used to visualize mathematical concepts and help create connections between abstract mathematics and real-world contexts (Bos, 2009). Ozel et al. (2008) found there were positive effects in attitudes toward learning, increased student achievement and conceptual understanding, and engagement with mathematics when technology was integrated in a meaningful way in the classroom. Meaningful integration included the use of technology tools such as calculators, interactive whiteboards, and student response systems that assessed student understanding of mathematics in real-time (Ozel et al., 2008). In order to be effective, these tools should be accompanied by teacher staff development addressing not only the use of the technology tools, but instructional strategies teachers could use to embed the tools into the math classroom (Windschitl & Sahl, 2002).

As students are becoming increasingly accustomed to using technology and computers at home, the use of technology in math classrooms has been associated with reduced anxiety and an enhanced self-esteem for students (Van Gundy et al., 2006). Students are familiar with using technology, specifically computers and calculators, outside of the classroom. Van Gundy et al. (2006) suggest when these tools are a part of the students' social lives, there is not a need to train the students on how to use the technology tools themselves, but classroom time can be spent on the mathematical thinking made more concrete using those tools. This allows the teacher to spend more time developing mathematical thinking and problem solving rather than teaching a technology tool (Silk et al., 2010). Students also see success at a faster rate because they are able to use the tools in a meaningful way and understand math by visualizing the problems (Van Gundy et al., 2006). This may lead to reduced anxiety and more engagement as students see relevance in the math content.

Proper use of technology can be a motivating and engaging factor as technology in the classroom helps students make connections with the use of technology outside of school (Becker, 2000). Proper use of technology can motivate students as they work on more complex tasks and produce higher quality work (Soucie, Radovic, & Svedrec, 2010). Technology can be motivating for students and often allows students to develop more sophisticated solutions to math problems (Soucie et al., 2010). By eliminating the need for students to spend cognitive resources on computation and memorization, technology allows students to think about math in a new way (Soucie et al., 2010). Math concepts at a higher level of thinking may now be accessible to students who have gaps in learning and may not have the background in computational skills as other students.

Technology tools allow students to analyze problems in depth, with emphasis placed on the process of solving the problem rather than just getting the correct answer to a math problem (Silk et al., 2010). As teachers are trained to use technology tools, they must also receive training in how to engage students in rigorous mathematical situations and discussions (Windschitl & Sahl, 2002). The technology tools can remove barriers for students and allow them to engage with rigorous mathematical tasks that might have been out of reach without the assistance of technology (Stinson, 2004).

Technology Tools

The "Technology Principle" as outlined by the NCTM identifies the critical role teachers play when selecting technology tools and how to use those tools within rigorous mathematics courses (NCTM, 2000). Technology tools, such as calculators, computers, interactive whiteboards, and student response systems are essential tools for students to use in order to develop reasoning and problem solving skills (Fadel & Lemke, 2006). The proper use of technology can enhance mathematics learning, support effective mathematics teaching, and influence what mathematics is taught (NCTM, 2000). Tools such as calculators can enhance mathematics learning because students can use multiple examples or have access to multiple representations of mathematical concepts (Ellington, 2003). Technology tools support effective mathematics teaching by allowing teachers to give students hands-on experiences with calculators and computers, collect formative assessment data with student response systems, or collaborate in a new way using interactive whiteboards (Fadel & Lemke, 2006). As teachers utilize technology in the classroom, the technology tools effectively influence what mathematical concepts are taught by encouraging teachers and students to focus more on problem solving and rigorous mathematical inquiry rather than computation skills (Bos, 2009).

Graphing calculators

Graphing calculators were first developed in the late 1980s and over the years have been adopted by middle school and high school math teachers as essential tools for the learning and discussion of algebra topics (Fadel & Lemke, 2006). As calculators have developed, the handheld devices now function more like small computers with applications for not only computation and graphing, but also spreadsheets, data collection and analysis, text authoring, dynamic geometry, and programming (Browning & Garza-Kling, 2010). The devices have become ubiquitous in high school math classrooms because of their small size, portability, relatively low cost, and required use on standardized tests (Fadel & Lemke, 2006). In addition to personal use of the calculator, newer versions of graphing calculators can also communicate via wireless network within a classroom network to share files and collect instant feedback from students. The numerous applications of graphing calculators have made them a likely tool for engaging learning experiences on the part of students.

Although graphing calculators have become a common mathematical tool in middle school and high school classrooms, many teachers still have their doubts over whether or not students who use graphing calculators are depending on the device too much and not developing critical number sense and computational skills (Cuban et al., 2001). In her research to determine the effects of calculators on student achievement, Ellington (2003) found both operational skills and problem-solving skills improved when calculators were an integral part of instruction and assessment. When the calculators were not part of the assessment, student achievement effects were still positive, but diminished. This implies students and teachers see assessment as a critical part of the learning process and will utilize tools in the classroom known to be a part of the assessment cycle. Teacher professional development in the use of the calculators can be critical to the effectiveness as teachers not only need to learn how to use the calculator as a tool, but also learn new instructional strategies integrating the calculator into the classroom (Warschauer, 2006).

Professional development in the use of calculators and how to embed their use into the Algebra 1 classroom is an important step in their integration and the link to student achievement (Browning & Garza-Kling, 2010). Because many teachers did not have graphing calculators as tools when they were students, it is possible teachers do not understand how graphing calculators can be useful in the early development of algebra skills and the best instructional uses of the tools (Ellington, 2003). When teachers have the appropriate pedagogical understanding of how to incorporate the graphing calculators into the classroom, students can use the tools to explore abstract mathematical concepts and communicate more clearly about visual representations (Huang et al., 2005).

When students are asked to share mathematical information and communicate about abstract mathematics, those students who have graphing calculators are more likely to answer questions correctly and have more thoughtful mathematical conversations (Abu-Naja, 2008). Abu-Naja (2008) found students who used graphing calculators to answer questions about functions had a better understanding of positive functions, negative functions, and infinity than students who did not use graphing calculators. Abu-Naja (2008) also discovered students who used the graphing calculators were able to adjust the windows of the calculator screen to describe how functions performed and have more thoughtful conversations about functions. Conversely, students who did not use graphing calculators were more likely to use survival thinking, where they simply tried to repeat what they had learned before. Ellington (2003) found similar results as students who were able to use graphing calculators were more likely to correctly describe how operations and computations were used to solve problems.

Graphing calculators are flexible tools that can be used both inside and outside of school to help students with mastering mathematical concepts. In a study of high school algebra classrooms, Laughbaum (2003) used study materials available on the graphing calculator to allow students to take math problems home with them and complete their homework on the calculator itself. His study found students who extended their learning outside of the classroom were more likely to learn algebra concepts at a deeper level, even if their mathematical abilities were below average. Laughbaum (2003) noted students found the calculators as an engaging tool and were more likely to practice mathematical skills at home on the calculator rather than using paper and pencil. Laughbaum (2003) also found graphing calculators can be an effective tool for the teaching of algebra because instead of taking time away from the math curriculum, it can extend the time students have to work with mathematics.

An important aspect of the graphing calculator usage is the student engagement that occurs through the use of this handheld technology (Browning & Garza-Kling, 2010; Ellington, 2003). Students are more likely to work longer on rigorous math problems because they have access to a tool assisting them with solving the problems (Soucie et al., 2010). Ellington (2003) found student attitudes were more favorable toward mathematics when graphing calculators were used in the classroom. That is, students' self-efficacy towards mathematics classes improved due to the success felt when solving rigorous math problems using graphing calculators.

Student response systems

Collecting formative assessment feedback on student performance is a critical part of the learning cycle (Van de Walle et al., 2010). If teachers are to know whether or not their instructional practices are making an impact on student learning, they should have access to instructional strategies that assess student understanding (Chappuis, 2009). Formative assessment of student learning should be an ongoing process allowing students to show what they know and provide an opportunity to learn through discussions about their successes and mistakes (Van de Walle et al., 2010). A technology tool used to collect student responses for formative assessment is an electronic student response system, which might also be called audience polling devices or "clickers."

Student response systems allow the teacher to pose a multiple choice question to the entire class, and then students respond by entering answers on a wireless device that connects to the teacher computer (Fadel & Lemke, 2006). Because students enter their responses from their desks, individual student data is anonymous to all other students. This anonymity assists with increasing student engagement and participation (Draper & Brown, 2004). Benefits from student response systems include instant feedback to students, formative feedback of student learning for teachers, and engagement on the part of the students in the learning process (King & Robinson, 2009). As students answer questions and see whether or not their answers are correct, they are gaining a sense of personal understanding of the material and are able to gauge their ability level against the level of the class (King & Robinson, 2009). This can be reassuring to students as they are motivated to learn more and respond correctly to teacher questions.

Cognitive research shows interest in a task positively impacts the engagement students take in the task and whether or not the students engage in deeper processing (Bos, 2009; Van de Walle et al., 2010). Student response systems have been shown to improve math classroom dynamics through engagement as students are required to engage in mathematical thought and select an answer (Draper & Brown, 2004). This is not the typical classroom in which one student answers a question posed from the teacher while the rest of the class waits for the response. All students in the classroom are required to engage in the thinking and select a response. Draper and Brown (2004) found anonymity is a key factor in the engagement. It is important teachers receive proper training in not only how to use the electronic systems themselves, but also how to share responses with the class and have conversations about the answers while allowing for anonymity of students (Fadel & Lemke, 2006).

The National Research Council's Committee on Increasing High School Students' Engagement and Motivation to Learn (2004) addressed active engagement as a key factor for student learning and success. Not only does engagement consist of behaviors and cognitive strategies, but engagement also requires effort, persistence, enthusiasm, pride, and enjoyment. Student response systems have been shown to increase many of these factors of student engagement (Draper & Brown, 2004; King & Robinson, 2009). Through the use of student response systems, not only do students learn about their own understanding of mathematics through metacognition from immediate formative feedback, but students also report using the "clickers" as fun (Draper & Brown, 2004). As students enjoy using the systems and responding to teacher questions, they may be more likely to engage in mathematics tasks requiring higher-level thinking skills.

Interactive whiteboards

One of the more popular technology tools to be introduced into mathematics classrooms is an interactive whiteboard, which allows teachers or students to interact with computer software through technical interactivity, or controlling the computer at the touch of the screen (Fadel & Lemke, 2006). Secondary math teachers report the interactive whiteboard is an important tool in the classroom because of its flexibility, versatility, and usefulness across age groups and settings (Slay et al., 2008). A major factor on whether the interactive whiteboard will produce significant benefits in mathematics understanding and achievement includes whether the teacher or the student is the person using the technology (H. J. Smith et al., 2005).

Interactive whiteboards allow teachers and students to interact with and use mathematical software tools including virtual manipulatives, dynamic geometry software, gaming software, and mathematical modeling tools (Fadel & Lemke, 2006). Bos (2009) found using virtual manipulatives has been shown to increase the capacity for students to model mathematical thinking, especially when using an interactive whiteboard because of its large size and the ability to present the material to the entire class. Bos (2009) also found utilizing interactive math objects on an interactive whiteboard, such as transforming equations or dynamic geometry, can help students develop visual representations of mathematical patterns, predictions, and replications. Slay et al. (2008) describe using interactive whiteboards as a pedagogical leap for teachers to overcome. Teachers who are used to teaching in a traditional classroom, where a chalkboard and textbook are the central instructional tools, might have difficulty in the transition to a technology-rich classroom where the interactive whiteboard and mathematical software take over the knowledge and instructional base (Slay et al., 2008).

Introducing interactive whiteboards into math classrooms can have beneficial effects, but there is much more needed than just the installation of the equipment. Experiences of teachers have shown in-service support and training are important if students are to see the benefits of the use of virtual manipulatives and interactive math software (Armstrong, 2005). Because the benefits of interactive whiteboards are only realized if students are using the equipment in an engaging manner, teachers need training in math pedagogy that allows for students to utilize, discuss, and present using the interactive whiteboard (H. J. Smith et al., 2005). A decentered classroom, where the students become the owners and presenters of information not only is a benefit of technology use, but has also been shown to be beneficial to mathematical pedagogy in general (Van de Walle et al., 2010).

Computer software

As computers have played a more pivotal role in education and society in general, computer software has been developed to assist students with visualizing or solving mathematical tasks (Hegedus & Kaput, 2004; Silk et al., 2010). Typical mathematical software might include student practice in fact fluency, algebraic graphing, dynamic geometry, or virtual manipulatives (Fadel & Lemke, 2006). Each of these software applications can have a beneficial effect if used in a meaningful and engaging way by the students (Bos, 2009).

Installing computers in the classroom is a fundamental step in ensuring students have access to mathematical software. The student-to-computer ratio is a key factor when planning for technology integration (Fadel & Lemke, 2006). If there is one computer in the classroom, it often becomes the domain of the teacher and the students rarely have access to use it (Becker, 1994). If there are a handful of computers, then students can rotate through the computer stations or work in small groups. In some schools the students might go to a separate computer lab where they can work at computer workstations on a rotating basis. Easy and equitable access to computer workstations is a factor in whether or not students use the technology in a meaningful way in the classroom (Becker, 1994).

Pedagogical changes may be needed for teachers who are transitioning from a traditional classroom to a classroom with computers available for students (Ertmer & Ottenbreit-Leftwich, 2010). One of the main factors in whether or not teachers will make the necessary changes to incorporate computer software in their instructional practices is their level of personal use of computers (Cuban et al., 2001). Teachers who use computers for daily tasks such as communication, word processing, and entertainment are more likely to use mathematical software in a meaningful way in the classroom (Cuban et al., 2001). Encouraging teachers to use computers for administrative tasks such as memos and attendance, although not directly linked to instruction, can increase their overall usage of computer use and therefore lead to a greater comfort in using technology (Cuban et al., 2001).

Professional development not only in the technical aspects of computer use, but also the pedagogical aspects of computer use are important if teachers are to use the computer software in an engaging way with students (Becker, 1994). Initial training on computer software is needed for teachers to be comfortable with understanding how to use the programs themselves before teaching students to use the programs (Ertmer & Ottenbreit-Leftwich, 2010). After the initial training on technical aspects of the computer software, pedagogical concerns of how to use the computer programs instructionally should make the bulk of training. In this way, the computer software is used to build mathematical concepts rather than becoming an external, detached part of the curriculum (Bos, 2009).

One-to-one computing

Unlike a graphing calculator, which is small and affordable, computers are a major investment for schools and portable laptops are often unaffordable (Fadel & Lemke, 2006). In "The Equity Principle," the NCTM (2000) addresses the need for an equitable and accessible mathematics curriculum for all students. The equitable classroom vision NCTM (2000) espouses requires all students have equal access to mathematical tools both in and out of school. This includes tools such as laptop computers students might carry with them from school to home, regardless of the students' ability to afford the technology (Norris & Soloway, 2010).

There is little research about the effects of a 1:1 student to computer ratio in math classrooms. Many schools have computer labs accessible to students at scheduled times, but equitable access for all students is a key component to the proper use of technology in classrooms (Ozel et al., 2008). Assigning students a laptop or tablet PC for mobile access makes technology an equitable resource for all students (Norris & Soloway, 2010). The "Equity Principle" as addressed by the NCTM (2000) includes the need for students to have equitable access to instructional materials and curriculum. All students should be able to access the curriculum materials used by the teacher and have the same opportunity to use technology tools that address the needs for multiple representations and communication (NCTM, 2000). By addressing this need for equitable access through a 1:1 student to computer ratio, schools are helping to ensure students have the technology regardless of their socio-economic status or ability to afford the technology at home.

As with other areas of technology usage in mathematics, if a 1:1 student to computer ratio is implemented in a school, it is a possibility teachers will need additional resources, training, and support to ensure student usage is appropriate and effective in the math classroom. Dunleavy and Heinecke (2008) found a link between use of 1:1 computing and improvement of test scores, but suggest more studies need to be completed in order to make generalizations. The findings of their study included the fact student achievement rose more in science than math after a two year 1:1 computing initiative. Possible reasons might include there were more resources available online for science than math, the science teachers might have received more staff development in the use of computers in instruction, or computers might lend themselves better to instruction in certain subjects rather than others (Dunleavy & Heinecke, 2008). There is more research to be done to determine where the differences exist to determine if 1:1 computing is truly an effective pedagogical tool in math classrooms (Ertmer & Ottenbreit-Leftwich, 2010).

The concept of 1:1 computing is a recent development in education and is expected to grow in the coming years as more classes and assessments are available online (Jacobs, 2010). Warschauer (2006) suggests 1:1 computing does not immediately show increased results in tests scores, but over time can be shown to increase student engagement, increase levels of student writing, and promote deeper learning. As both students and teachers become more comfortable with technology inside and outside of the classroom, and as teachers discover more appropriate ways to incorporate laptops into the math classroom, computer usage is expected to be more significant as a mathematical tool rather than just a novelty in the classroom (Jacobs, 2010). Some administrators see the lack of immediate results as a reason to believe 1:1 computing is not effective, but Warschauer (2006) suggests administrators may have to wait as long as three years before seeing any benefits from the implementation.

Classroom instruction, classroom management, and student engagement are quite different within a traditional classroom and a classroom incorporating 1:1 computing. Teachers and students have access to more communication tools and instructional materials than in a classroom centered on textbook lessons (Silk et al., 2010; Windschitl & Sahl, 2002). In most cases, successful implementation of 1:1 computing is a function of the classroom teacher (Norris & Soloway, 2010). If the classroom teacher is able to adjust and use new pedagogical tools, the students are allowed to research, communicate, and learn in a more engaging and meaningful way because of the technology tools.

Professional development and technology competency of the classroom teacher is important if the computers in the classroom are going to complement the math instruction rather than be an inhibition to mathematical thinking (Baltus, 2010). Some teachers see the computers as an unwelcome distraction to students and look to find ways not to use the laptops during class so students are focused on mathematics using a more traditional paper and pencil approach (Baltus, 2010). In addition, Baltus (2010) suggests if teachers themselves are not able to use the computer efficiently they often do not allow the students to use the tools for fear the students will outperform them in the area of technology. Because of a fear of knowing less than the students in the area of technology, some teachers may avoid using the laptops in class.

Tablet PCs are an option for 1:1 computing useful in the math classroom (Godsall, Crescimano, & Blair, 2005). Tablet PCs are convertible devices that allow students to use the computer like a traditional laptop, or swivel the screen to create a tablet device and write with a stylus on the screen. This is a critical function for math classrooms where it is often difficult to enter mathematical equations and drawings with a traditional keyboard and mouse (Godsall et al., 2005). The use of tablet PCs in a math classroom allows students and teachers to write traditional math equations and drawings in an electronic notebook, and the wireless infrastructure allows for more student interaction both in and out of the classroom (Fister & McCarthy, 2008). As students have more interaction and engagement through the use of pen technology, the math concepts of multiple representations, dynamic geometry, and communication using math symbols are more likely to transfer from the technology tools to student understanding.

Self-efficacy

Achievement in mathematics has been shown to be related to students' perceived self-efficacy with regards to past experiences in mathematics courses (Usher, 2009). Self-efficacy refers to a person's belief he or she has the skills and knowledge to successfully complete a task (Bandura, 1989). Throughout Bandura's research, he has shown self-efficacy can be a determining factor in student success. Students who believe they have the skills necessary to complete a task will try harder, engage more, and achieve at higher rates than students who have a negative attitude or low self-efficacy towards mathematics (Stevens, Harris, Aguirre-Munoz, & Cobbs, 2009). Technology tools allowing students to access more rigorous mathematical tasks not only engage students in the mathematics, but give them a more positive outlook towards their mathematical abilities (Fast et al., 2010).

Over the past forty years, teacher efficacy has been studied as a way to explain how teachers' perception of their work impacts the performance of students in the classroom (Tschannen-Moran et al., 1998). Teacher efficacy towards their own work can influence the level at which students learn and explain teacher capacity to motivate or engage struggling students (Guskey & Passaro, 1994). The RAND organization in the 1970s added questions to a teacher survey that first looked to analyze whether teacher perception of their own work lay within themselves or the environment (Armor et al., 1976). The information from these questions led to the development of theories analyzing internal and external factors that influence teacher efficacy. This study will expand on the research from the RAND organization by linking technology integration to teacher efficacy in the Algebra 1 classroom.

Theoretical framework

Bandura's (1986) research on social cognitive theory suggests students have little incentive to act unless they believe they possess the skills necessary to produce positive results. Students construct their self-efficacy beliefs through their interaction in class, the most important of which is their previous academic performance (Bandura, 1997). By providing students an opportunity to have positive experiences in math class, teachers can assist students with developing positive self-efficacy beliefs towards their math performance. Student engagement is a key factor in student achievement, with students who are engaged in rigorous mathematical tasks showing increased achievement (Van de Walle et al., 2010).

The classroom environment plays a role in the student engagement that might affect student self-efficacy. Fast et al. (2010) studied the effects of perceived classroom environment on students' self-efficacy beliefs and student achievement. They found middle school students who reported they were in classrooms that were more caring, challenging, and mastery-oriented had both higher levels of perceived self-efficacy and higher scores on math achievement tests. Fast et al. (2010) suggest for teachers to help students increase their perceived self-efficacy towards mathematics, teachers need to ensure the classroom is a challenging, student-centered environment, with supports for students who are struggling.

Math self-efficacy

Self-efficacy beliefs have been shown to be particularly aligned to student achievement in mathematics (Stevens et al., 2009). Because of the abstract skills needed for success in algebra, students need to know they possess not only the algebraic reasoning skills to solve a problem, but also the foundational skills in proportional reasoning and fraction concepts associated with preparedness for algebra (Baltus, 2010). Ensuring students have positive experiences in mathematics through communication, visual representations, and engaging lessons can assist them with building a positive self-efficacy (Van de Walle et al., 2010). Teachers can assist students with understanding their strengths and weaknesses in mathematics so students can build their own self-efficacy beliefs.

Feedback through formative assessment can be a tool used by teachers to ensure students have a clear understanding of their knowledge and skills with regards to mathematics. An integral part of formative assessment is ensuring teachers give students authentic feedback on their progress so students understand how they are progressing towards well-established goals (Chappuis, 2009). If students are to truly understand if they have the skills necessary to solve rigorous math problems, they need feedback from teachers who will guide them and ensure their students are building mathematical knowledge (Stevens et al., 2009). Chappuis (2009) reports teachers can provide feedback through conversations with students, rubrics, or peer assessment. Each of these venues may provide students with information assisting them in building self-efficacy beliefs towards mathematics.

Given proper feedback of their math performance, students can create goals for their performance in math that may affect their overall self-efficacy towards math and their achievement. In a study of middle school math students, teachers provided feedback from which students decided if their success was from internal or external causes (Yailagh, 2009). Those students who believed their success stemmed from internal causes were more likely to create higher personal goals for their math achievement, and ultimately scored higher on math achievement tests (Yailagh, 2009). In addition to the internal versus external attributes, the level of goal setting was a predictor of student achievement (Yailagh, 2009). This aligns with the goals of NCTM and NCLB to provide all students a rigorous, challenging curriculum and then provide supports to ensure students find success at an early age (Aspen Institute, 2007; NCTM, 2000).

Technology self-efficacy

Self-efficacy in the classroom may include many factors, not all of which are directly related to academics. As teachers increasingly use technology tools in the classroom, positive experiences using computers or calculators to solve problems can increase the students' technology self-efficacy (Morris & Thrasher, 2009). Teacher beliefs and self-efficacy towards technology tools can be a factor in whether or not the tools are used in a meaningful way in the classroom (Paraskeva et al., 2008). The technology self-efficacy of teachers affects the way in which they use technology tools, which in turn relates to the students' perceived self-efficacy. Staff development in technology tools as an integrated part of the classroom instruction can assist teachers in increasing their technology self-efficacy (Paraskeva et al., 2008).

Increasing technology self-efficacy among teachers can assist with ensuring teachers are using technology tools in a positive way (Paraskeva et al., 2008). Wilfong (2006) found technology self-efficacy is more likely to impact positive usage of computer by decreasing both computer anxiety and computer anger. In fact, in Wilfong's (2006) study, technology self-efficacy had a larger impact than computer experience and computer use. Increasing technology self-efficacy might be completed through targeted, timely staff development opportunities for teachers. By completing an intense summer staff development targeted on using technology, and then having follow up training throughout the school year, Watson (2006) found technology self-efficacy was increased in secondary teachers. The teachers who received the targeted training showed increased self-efficacy towards technology for several years after the training, positively affecting their long-term classroom pedagogy (Watson, 2006).

Locus of control

Teacher locus of control was studied by Rose and Medway (1981) in an attempt to understand the levels of internal and external control teachers felt towards student performance and engagement. Teachers who reported higher levels of internal control felt the work they did impacted student achievement and motivation. Teachers who reported higher levels of external control felt student achievement and motivation were pre-determined by the students. These teachers felt they could not change the environment in a way to significantly impact student performance. Teachers who reported higher levels of internal control were less likely to discipline students negatively and were more likely to implement innovative teaching strategies (Rose & Medway, 1981). By looking at both internal and external factors, this study will analyze whether teachers perceive they have control over the use of technology tools in the Algebra 1 classroom.

Guskey and Passaro (1994) used the prior research to develop four broad categories more clearly defining teacher efficacy. The four categories Guskey and Passaro (1994) developed are called: personal-internal (P-I), personal-external (P-E), teaching-internal (T-I), and teaching-external (T-E). First, these categories examine teachers' personal feelings towards teaching versus their overall feeling of how teachers can impact student performance. This personal versus teaching dimension leads to an interesting view of self-efficacy versus collective efficacy of teaching effectiveness. Second, these categories examine internal versus external factors. These factors attempt to explain how teachers' view whether student performance is pre-determined, or if teachers can have an impact on student performance.

The research regarding personal versus teaching factors and internal versus external factors was completed before an influx of technology tools have entered the algebra classroom (Fadel & Lemke, 2006). The use of such tools has an impact on teacher efficacy, because teachers are being asked to implement instructional strategies for which they do not have prior experience or training (Wilfong, 2006). This study will attempt to analyze how technology tools impact teacher efficacy within the four categories defined by Guskey and Passaro (1994).

Summary of Literature Findings

With increasing levels of technology usage in K-12 schools, there is a need for research into the effects of technology tools on mathematics achievement. The literature regarding technology usage shows a benefit from using technology because of the engagement of students and the ability for students to visualize and communicate about mathematics in a new way. In order for the positive benefits to be realized, professional development into the technology tools and a new pedagogical method are critical aspects of pre-service and in-service teacher training (Ertmer & Ottenbreit-Leftwich, 2010).

In addition to proper training for technology use, equal access to technology tools is something schools need to investigate in order to fulfill the technology and equity principles as outlined by the NCTM (2000). A 1:1 student to computer ratio is a lofty goal for schools working with limited financial resources and limited technology infrastructure. More research is needed into how schools can effectively integrate 1:1 computing into mathematics classrooms and whether or not the gains seen by schools can be increased and sustained over many years (Warschauer, 2006). In any case, technology integration is an important area for state and district leaders to consider when writing curriculum, budgeting for resources, and training teachers for working with students in an engaging way.

As more technology tools are being introduced and utilized in meaningful ways in math classrooms, understanding how self-efficacy towards technology interacts with student knowledge is a topic where more research is needed. If students believe they have the skills necessary to use technology in a meaningful way, the use of meaningful technology activities should be aligned with greater engagement in tasks and greater understanding of mathematical concepts (Morris & Thrasher, 2009). There is a gap in the literature with regards to research in the interaction among technology self-efficacy, math self-efficacy, and student achievement. By understanding these interactions, teachers should be better equipped to leverage technology as a meaningful instructional tool in mathematics.

CHAPTER III

RESEARCH METHODOLOGY

This study used a qualitative case study approach with semi-structured interviews and classroom observations to collect data (Gall, Gall, & Borg, 2007). By using a case study approach, the feelings of efficacy among the teachers was made apparent through their interview data and observational data. Data collection occurred during the spring semester of 2015.

Data Sources

Purposeful sampling was used to choose participants for the study including three teachers and their supervising administrator from a comprehensive high school with a 1:1 student-to-computer ratio. This study focused on ninth grade Algebra 1 classes because Algebra 1 has been identified as a critical factor in future success in high school and college (Cavanagh, 2008; Spielhagen, 2006). Teachers identified provided for different perspectives as far as years of experience teaching with technology tools. The school selected has used tablet PCs in instruction for seven years. This is important because the review of literature suggests tablet PCs are the most appropriate device for math classrooms and positive effects are not immediately evident in the classroom after initial implementation of a 1:1 program (Fister & McCarthy, 2008; Warschauer, 2006).

School profile

Northwest High School was the campus selected for the study. It is a comprehensive high school of approximately 3,800 students in a suburban community of

Houston, TX. Northwest was selected because the students in the school utilize school-owned, convertible tablet PCs for the delivery of instructional materials and communication or collaboration during and after the school day. The school first implemented 1:1 computing seven years prior to the study and has been able to move past initial implementation to a sustained model of training and support for teachers.

At the time of the study, Northwest High School was a traditional, comprehensive high school. It held students in grades 9-12 on a single campus. Of the students at the campus, 9% were African American, 28% were Hispanic, 52% were white, 8% were Asian, and 3% other ethnicities. There were 23% of the students on the campus categorized as economically disadvantaged. While the 1:1 computer program sought to equalize student access to technology resources, it is still possible the students who were categorized as economically disadvantaged may have had difficulty accessing online resources away from the campus. The campus schedule provided for seven 45-minute class periods each day, with Algebra 1 classes meeting daily.

Student performance in Algebra 1 at Northwest High School was slightly higher than state averages. In 2014, 80% of Northwest High School Algebra 1 students passed the end-of-course exam while 78% of students statewide passed the assessment. Achievement gaps were present for Hispanic and economically disadvantaged students groups at Northwest. Both student groups scored at 72% passing on the Algebra 1 end-of-course exam in 2014. In order to provide remediation for students who did not meet passing standard, a 30-minute remediation period was added for students to receive additional instruction in mathematics concepts.

Students at Northwest High School checked out a computer to use during the school day they could also take home to use for school work when not on the school campus. Students had wireless access to internet resources at the school campus. Teachers worked to ensure homework assignments completed on the computer could be accomplished even if students did not have internet access at home. Additional technology was available in each math classroom for the teacher and students to use during the school day. These technology tools in each classroom included a data projector, an interactive whiteboard, student response systems, and a class set of graphing calculators.

The convertible tablet computer was specifically chosen by a group of teachers and administrators to assist the math teachers with implementation of the curriculum. The convertible tablet computers are laptop computers with a touchscreen that can swivel and close to become a tablet device. A stylus allows the students to interact with the tablet computer by tapping or writing on the screen. Because the convertible tablets have a touch screen and stylus with which students can write equations or draw math figures, it was specifically chosen to be more beneficial to the math teachers.

Participant profiles

Teachers participating in the study had between 5 and 20 years experience teaching Algebra 1 at the high school level. Two teachers were female and one was male. The teachers' use of technology varied widely for both personal and professional use.

Purposeful sampling was used to identify teachers for the study. Twelve Algebra 1 teachers from Northwest High School were considered for the study (see Table 1). The teachers were asked questions regarding their age, race, gender, years of service, comfort with using technology, and their perceived levels of technology integration in the classroom. These results were analyzed to choose three teachers who presented a range of teaching abilities and styles. The teachers were asked to serve as participants, and their participation was voluntary. None of the teachers asked to serve as study participants declined the invitation.

Table 1

Teacher Participant Identification

Teacher	Gender	Age	Race	Years of Experience	Perceived Level of Technology Comfort	Perceived Level of Technology Integration
1	Female	43	White	20	5	3
2	Female	37	White	15	3	2
3	Male	46	Asian	5	2	0
4	Female	23	White	1	4	3
5	Female	54	White	30	2	2
6	Female	35	Afr Amer	10	3	2
7	Male	40	White	15	4	3
8	Male	25	White	2	5	4
9	Female	60	White	25	2	2
10	Female	41	White	18	4	3
11	Female	46	White	22	5	3
12	Female	24	White	2	4	1

Note. Teachers 1, 2, and 3 in the table were chosen for the study. Perceived levels of technology comfort and integration were self-reported by the teachers and scored 0-5 with 0 being the lowest level and 5 being the highest level.

The first teacher chosen for the study was Teressa Watkins. She was a 20-year veteran teacher who taught Algebra 1 her entire teaching career. She started teaching at the middle school level and taught Algebra 1 to eighth grade students who were advanced in their studies. She transferred to Northwest High School five years prior to the study, two years after the initial implementation of 1:1 computing. Teressa described herself as a PC gamer who spent hours on her home computer playing games which then transferred to her work in the classroom utilizing the computer for e-mail and simple office tasks. Although Teressa felt she was quite confident in using computers for personal tasks, she felt using computers for instruction was a struggle. She liked when professional development was specifically targeted to using technology tools in Algebra 1 so she did not have to spend time trying to plan for herself how to integrate the technology tools.

The second teacher chosen for the study, Janet White, taught high school math for 15 years prior to the study. She also spent her entire teaching career in Algebra 1 classrooms at two different high schools. At the first high school where she taught, little technology was available for her to use in the classroom. She had a teacher computer and graphing calculators for students. She moved to Northwest High School eight years prior to the study, one year before the 1:1 implementation started. She took part in the initial training for teachers on the use of tablet PCs for instruction. She worked with the Algebra 1 PLC since that time to find resources to integrate into the classroom. Janet described she did not use a computer for personal use at all until she started teaching with computers and learned more. She quickly adapted and used the computer quite often for both personal and professional use after getting started.

John Smithson was the third teacher chosen for this study. He was a fifth-year teacher who started teaching as a second career after completing an alternative certification program. John taught primarily in the co-teach classes where students with special education accommodations were integrated into the on-level Algebra 1 classes. Northwest High School was the second high school where John taught in his short career. He had only been on the campus for two years. Prior to teaching at Northwest, John taught at a school with little technology tools available to students. He had a difficult time adjusting to the level of technology available to students during his two years at Northwest. Prior to teaching at Northwest, John used computers at home for certain tasks such as e-mail and web surfing, but had no formal training as to how to integrate technology into instruction.

Cindy Sharp was the assistant principal who monitors curriculum and instruction for Northwest High School. She was a former math teacher and supervised the teachers as well as planned professional development opportunities for the teachers surrounding instructional strategies and technology integration. Cindy's technology use was moderate both personally and professionally. She became an administrator during the transition period when Northwest High School first adopted 1:1 computing. Cindy was on the administrative team that planned and implemented the initial training for teachers on using 1:1 computing and helped plan and implement additional training over the seven years she spent as an administrator.

Data Collection

In order to complete a case study for the current study, interviews, observations, and document analysis were used to gather information. The purpose of a case study is to provide a rich description of a specific circumstance in order to present information that may provide insight into that circumstance (Creswell, 2007). Data was collected until saturation provided enough details of the participants to tell a complete story and analyze the circumstance.

The data collection of this study included semi-structured interviews of the teachers to obtain data for analysis (Creswell, 2007). Three interviews occurred at regular intervals during the spring semester of 2015. Questions were in an open-ended response format to solicit candid information from the participants. Interviews consisted of questions to assess accessibility and comfort with using technology to teach algebra. Information gathered through the interview process included teacher efficacy, addressed in four broad categories: personal-internal (P-I), personal-external (P-E), teaching-internal (T-I), and teaching-external (T-E) (Guskey & Passaro, 1994).

Classroom observations were conducted for at least three hour-long classes from each teacher throughout the spring semester of 2015 (Creswell, 2007). The scheduled observations focused on collecting data to assess the level of computer use in the classrooms, the depth of instruction that occurred, and teacher-student interactions. Field notes were collected and sorted into four broad categories examining the internal and external forces that affect efficacy (Guskey & Passaro, 1994). Documents such as lesson plans or minutes from teacher planning sessions were used to analyze the depth of technology integration used in the classrooms. The observations were used to triangulate the findings and themes from the interview data.

Data Analysis

Analysis of the data was done through the use of descriptive case studies (Gall et al., 2007). A thick description of the data collected was used to depict the perceptions of technology usage in the Algebra 1 classrooms. An a priori theory surrounding teacher efficacy was used to determine themes to describe the self-efficacy of teachers in the study (Creswell, 2007). Categories for analysis were grounded in the research literature regarding four broad categories: personal-internal, personal-external, teaching-internal, and teaching-external (Guskey & Passaro, 1994). The benefit to using an a priori theory is it assisted with guiding the data collection and analysis in a cohesive manner (Creswell, 2007).

Reliability and credibility was assured through member checks and triangulation (Denzin & Lincoln, 1998). Member checking was used with the interviewed teachers and administrator in order to allow them to analyze the emerging themes and indicate whether the reconstruction was recognizable. Triangulation was done by using multiple sources of data including interviews, observations, and document analysis to ensure the interview data reflected the activity occurring in the classrooms.

Limitations

A possible limitation to the study is the fact the research is being done in a school using a specific technology integration model. It is anticipated the findings would be applicable to other high schools using a 1:1 student-to-computer ratio. However, the findings could also be applicable to schools at other levels, including middle schools or universities in which teachers or professors are working in an environment in which all students have access to the same technology tools.

The study findings could possibly be extended to be applicable to schools using other technology tools or integration models. Schools which utilize a “bring your own device” model allow students to bring their own mobile computing device from home. Schools could interpret the findings from the study with regards to teacher understanding and usage of technology tools in general whether 1:1 or bring your own device. By generalizing the findings, these schools could have conversations surrounding the overall teacher professional development model and self-efficacy findings.

Another limitation in the study includes the closeness of the researcher to the school. Because the researcher works in a supervisory mode, although lateral in nature, the teachers might feel anticipation in providing responses. However, the nature of questioning surrounded the technology use and integration, an area in which the researcher is not directly related as he is responsible for the curriculum pedagogy and content. This closeness of researcher and participant may provide closer insight, however, as the teachers may feel more comfortable sharing their concerns with a researcher they already know and trust.

Summary

The purpose of this chapter was to provide and explanation of the methodology used to conduct the study. This case study began in the spring of 2015 after IRB consent was obtained. During the spring semester initial interviews, data collection through observations and document analysis was completed, as well as initial analysis of the data. Final data analysis, editing, and revising took place in the summer 2015.

CHAPTER IV

RESULTS

The purpose of this study was to understand the influence of teacher self-efficacy on the utilization of technology tools in a 1:1 computing environment in Algebra 1. In the previous chapter, the data methods were described along with a description of the participants. This chapter presents the results from the current research and findings from the current study.

The results were analyzed utilizing themes from an a priori theory showing how teacher locus of control contributes to self-efficacy as it relates to instruction (Guskey & Passaro, 1994). Interview results were categorized as belonging to one of four categories as they relate to locus of control: Personal-internal (P-I), Personal-external (P-E), Teaching-internal (T-I), and Teaching-external (T-E).

Personal factors included beliefs or behaviors that impacted individual teachers either inside or outside of the classroom. The factors that fell into this category most often related to the participants personally. The responses included the word “I” rather than “we” or “teachers” when relating to technology usage or efficacy (Guskey & Passaro, 1994). Personal efficacy factors impacted teachers on an individual basis. The beliefs identified as personal were often built by teachers in their environment outside of the classroom, or in early experiences in college or teacher preparation programs. These factors impacted teaching factors as teachers built on personal experiences when working in the classroom.

Teaching factors were beliefs or behaviors directly related to the instructional strategies and decisions made by teachers as a group. The responses coded into the teaching category included the words "we" or "teachers" instead of "I" when discussing how technology was used in the classroom (Guskey & Passaro, 1994). Efficacy built as a team directly impacted the classroom as teachers worked together to design lessons, attend professional development, or teach students. The behaviors and beliefs in the teaching category impact student achievement because teachers who have a higher efficacy towards their own classroom practices have students who achieve at higher levels (Bandura, 1977).

It is important to distinguish between personal and teaching factors when analyzing efficacy. Although personal and teaching factors may relate to each other, there is a difference in how teachers relate confidence in using computers for personal use versus using computers in an educational setting to make good decisions for instruction (Ashton & Webb, 1982). According to Ashton and Webb (1982) the personal and teaching dimension can act independently of each other. For example, a teacher might feel she has little personal efficacy in using technology for personal use, but when working with colleagues, the teachers as a group can use technology with great confidence and efficacy. Using the two factors, personal and teaching, to describe the responses is important because personal efficacy factors often have a positive effect on teacher efficacy factors (Cuban et al., 2001).

Internal and external factors relate to the locus of control teachers feel they have to make changes to any barriers in place. Internal factors are ones the teachers have the most control to change. External factors would require systemic or institutional change. In order to have an impact on organizational change when implementing a new technology initiative, administrators should analyze the external factors in which teachers feel little to no control to change (Guskey, 1986). By using internal and external factors in conjunction with personal and teaching factors, it may be possible to determine suggestions administrators can take to impact the efficacy with which teachers face instructional changes.

Subthemes were based in the research and chosen based on participant responses to assist with analyzing the interview and observation data (see Table 2). Teacher responses were coded into one of the four themes based on the phrases used to describe personal or teaching dimensions and the locus of control teachers felt in describing the solutions to the barriers. By analyzing the responses based on the themes and subthemes, implications for practice can be sought based on the work administrators and specialists can do training and preparing teachers to utilize technology tools for meaningful instruction.

Table 2

Themes and Subthemes Utilized for Data Analysis

Themes	Subthemes
Personal-Internal	Personal computer proficiency Computer confidence and self-reliance Personal technology choices
Personal-External	Student technology confidence Technology professional development
Teaching-Internal	Technology instructional choices Professional learning communities Teacher preparation programs
Teaching-External	Expectations of technology usage Mathematics technology resources Differentiation of student processes Subject specific professional development Grading policies that interfere with implementation Student distraction caused by technology access

Personal-Internal

The first theme used to categorize interview data was personal-internal. Teacher perceptions and observation data categorized as personal-internal were those that were personal beliefs of teachers and which teachers felt they had a great deal of control to change or alter. The teacher locus of control impacts efficacy as research has shown the greater level of control teachers feel they have over processes, the higher their level of efficacy in implementing the processes (Armor et al., 1976).

Personal factors are behaviors or feelings that relate to an individuals' belief they have the skills and actions to make positive changes in their environment (Guskey & Passaro, 1994). By analyzing personal factors in addition to teaching factors, it is apparent a greater influence on teachers' personal choices in the classroom emerge. The personal beliefs held by the teachers in the study included those built outside of the classroom, especially with early learning about computer skills. The teachers who had a greater personal belief system with regards to computers and technology had a classroom embracing technology more than those who had a lower personal belief system.

The locus of control teachers felt impacted the classroom greatly. Teachers who focused on behaviors and beliefs within the internal locus of control had greater flexibility to make sustained changes. Those teachers who focused on an external locus of control tended to place blame on other people or policies for why change did not occur in their classroom with regards to technology usage. The internal locus of control conversations tended to be more positive in nature as teachers had the ability to make the changes they described.

Personal computer proficiency

Interview questions including the level of personal use of computers outside of the classroom were used in order to develop an understanding of the level of computer competence or comfort of each participant. The level of personal computer usage tends to relate to the level of computer use in the classroom for instructional purposes (Cuban et al., 2001). Data from interviews and observations tended to indicate teachers who had higher personal proficiency using technology tools had a higher level of computer usage in the classroom with students.

By understanding each participant's level of personal computer usage, the levels of classroom use would be expected to be in direct relation. This falls into the personal-internal framework of Guskey and Passaro's (1994) theory because the level of computer usage is individualized to each teacher, and there is a high level of influence each teacher has on his or her own personal usage. Teachers indicated through interviews how they chose to learn or not learn about technology in their college or pre-college education based on their interest in technology. Learning more about using technology for personal use tended to impact the technology used in the classroom.

Janet was not a computer user until she started using a computer at work for the 1:1 program at Northwest High School. Janet described her early experiences with technology:

> I didn't truly start using a computer for myself until college, so around 20-ish when I got my first PC in my apartment. Even before then the college gave me an e-mail address, but I used it like three times. It was my senior year in college that I had to do some research for my education classes. I tried to use this thing called the internet. It was difficult, I didn't know what I was doing. When I got my first computer I used it to send e-mails and type a few papers, but that is about it.

Janet shared she struggled to start using the computer at school because she did not know the basics of word processing, spreadsheets, or e-mail. She learned quickly how to use the computer for technical tasks because the technology specialists at the school would have weekly training sessions designed around basic computer skills. She made changes in her practice to include computer tasks such as e-mail, electronic gradebook, and word processing in order to be more effective and efficient in her work. Outside of the classroom today, Janet said she rarely uses a computer other than web surfing or checking personal e-mail.

Although Janet searched for training on using technology in the classroom, she felt she struggled with the lack of training available for meaningful instruction. She had to rely on herself and her colleagues to understand how the personal use of computers could translate into the classroom. For example, Janet described how she had to take her knowledge of websites and web tools to search for math materials and activities. Without her personal experiences using web tools, she would not have had specific ideas to use for math.

Of the participants in the study, Teressa was the teacher who used technology the most outside of the classroom. She described herself as a gamer who would use technology for entertainment at home prior to having computers available in the classroom. Teressa explained,

> I used the computer at home all the time. I was a computer nerd. I was a gamer. I did a lot of gaming on the internet. I used computers more at home when I didn't have a computer in my classroom.

She said she was able to learn on her own how to use the computer for productivity work at school from her earlier successes using computers for personal use at home.

This prior mastery built efficacy from which she could transfer knowledge into the classroom. It was apparent from observations in the classroom Teressa used the most technology tools of the teachers in the study. It was her personal comfort and proficiency with computers Teressa attributed to the use of technology tools in the classroom. Because she was already comfortable using computers, she taught herself how to use computers for formative assessment in her classroom, utilizing online quizzes from the learning management system in order to gather quick feedback from students. She expressed concern the rest of her colleagues on the Algebra 1 team did not feel as confident in using computers for personal use because they often relied on her to explain how to accomplish certain tasks. However, she felt it was important for her to share with her colleagues because it would benefit them in the long run.

Computer confidence and self-reliance

Teacher confidence in using computers is related to the level of efficacy with which they use computers in the classroom for meaningful instruction (Ertmer & Ottenbreit-Leftwich, 2010; Morris & Thrasher, 2009). When teachers feel self-reliance in using computers and creating tasks for students, then it is more likely they will utilize the technology in the classroom. In the classroom with students, computer confidence is important because the teachers in the study felt they needed to be able to explain how the technology worked or how to fix the technology if things went wrong. When teachers in the study were not confident in their personal use of technology, they tended to choose instructional methods that did not rely on computers.

The teachers in the study related different levels of confidence in their use both for personal tasks and for instruction. Confidence relates to the personal-internal framework because confidence in using computers is built by individual teachers inside or outside of the classroom and the teachers have the ability to impact their confidence levels based on their personal experiences (Guskey & Passaro, 1994). Self-reliance is particularly important as teachers must feel comfortable instructing using computers when they are the only adult in the classroom. When the teachers were confident in using computers outside of the classroom, then this reflected the confidence in the classroom as well.

Of the teachers in the study, it seems Teressa had the most mastery experiences outside of the classroom, which would relate to her high levels of confidence in using the computers. She said her personal use of computers made her feel more comfortable when it came to utilizing the computer in the classroom. This level of comfort in using computers may have meant she was able to integrate technology more seamlessly in her classroom than her peers when first implementing the 1:1 program. She was confident in using the online webpages, analyzing website content, and utilizing the learning management system. However, her confidence was limited to personal use of the computer and did not necessarily translate to mathematics instruction due to a lack of training in how to use the computers for instruction.

John was confident in his personal use of computers, but less confident when it came to utilizing the computers for instructional purposes. As an alternatively certified teacher, he did not have formal educational training in college regarding technology tools for instruction. He learned on the job from professional development sessions how to use the computer tools, but not how to use them for instruction. He tended to rely on the students to know themselves how to use the computers so they could log into the learning management system and use online tools. He expressed he did not feel confident in teaching the students how to use the computers or the software related to the classroom. He stated,

> I think I know reasonably good how to teach with computers in class, but well I'm afraid actually. My priority is making sure they learn. Using technology or not. I'm afraid, a bit delayed actually. If they were more comfortable using technology at a lower grade it would be easier for us

John felt he did not have enough training to feel confident in teaching the students how to use the computers. His belief in the students' level of computer use impacted his confidence level in using the computer for instruction.

Personal confidence in using computers seemed to be impacted by the environment of high-stakes testing for at least one teacher in the study. John explained because of standardized tests and classroom setup, he was unable to use the computers for instruction to build mastery experiences:

> I'm pressed preparing for end of course tests. It has big impact on my class and school. So that is probably why whatever I do centers around teaching that is tailored toward higher pass rates for the end of course instead of using technology. I'm sharing this classroom with other teachers. I can't use this classroom the way I really want to. The interactive whiteboard is covered here so I can't use it. Students open the learning management system, download a worksheet. That is the most technology they use.

Building personal confidence using computers in order to enhance instruction could be a goal for John in order to build his efficacy with using technology. He has allowed the environment of the classroom and pressure to raise achievement scores to impact usage, rather than finding ways to use technology tools within the confines of the current environment.

Personal mastery experiences may help build confidence for the teachers (Bandura, 1997). A lack of personal mastery experiences means John should reach out to others in order to learn vicariously from the other teachers on his team and ask for assistance in building his confidence in teaching the students. Administrators can assist with this personal struggle by observing classrooms to understand which teachers are lacking the confidence, experience, and learning strategies to move forward and help them learn from vicarious experiences.

Personal technology choices

As the teachers developed lesson plans and decided on daily classroom activities, it became apparent from the interview and observation data personal choices regarding technology use impacted the classroom experience for students. As teachers followed the district and state curriculum, they had personal decisions to make as to when and how much technology should be used in the classroom. At Northwest High School teachers were encouraged by their administrators to personalize their classroom based on their own teaching style. Each classroom environment was personalized to the teacher's style of teaching, and likewise the classroom activities reflected their personal technology choices.

Teacher implementation of curriculum, including technology choices, impacts the classroom because it allows the teacher to implement a caring and challenging environment (Fast et al., 2010). Classroom choices or classroom and technology management in this context relates to the physical classroom setup, sharing of information and documents between teacher and students, and relaying instructions to students. This personal construct is built on teacher beliefs and practices in how they set up classroom rules and procedures. Teachers have an impact on how their classroom is run based on the procedures they set with students, so this falls into the personal-internal construct.

This subtheme was among the highest level of internal locus of control for teachers in the study. Although they planned together as a team, each individual teacher made choices daily impacting the classroom activities and environment. These choices tended to reflect the comfort levels in which they had with technology outside of the classroom. The teachers also described their personal education in which technology did not play a role. Both Janet and John explained they did not learn mathematics in high school and college with technology; therefore, their students did not necessarily need the tools either. These internal beliefs impacted the type of instructional tools they were willing to use in the classroom. In observation data, it was clear Janet and John had the lowest levels of technology usage in daily instruction.

Across the board from the teacher interviews and observations, it was evident technology was used as a managerial tool for the teachers. Use of the computers was rarely for instruction of mathematical concepts. The computers were used primarily for assigning work, turning in grades, and providing written feedback to students. Janet described when teaching a new math concept, she felt direct teacher instruction was necessary for her students to gain new knowledge:

> At the Algebra 1 level it felt like there needed to be a lot of teacher there, guiding. Just turning these kids loose on an activity, I didn't have any good enough activities to discover. I had to do a lot of the math with them. And then there was the issue of kinesthetic learners, and they could only look at manipulatives on the computer.

She did not feel comfortable in letting students explore new concepts on their own through research or interactive activities, or online curriculum because she would have to spend too much time reviewing the concepts with the students if they did not understand.

The computers seemed to be more of a managerial tool than a curriculum tool in Teressa's classroom. Teressa described how the students take notes on the computer rather than on paper. She said,

> The first year I didn't use them a whole lot, just because I didn't know what all was out there. Basically, it was the teacher presenting on the screen, but the kids had the PowerPoint on their computer and they could go through the PowerPoint and take notes on the computer. Compared to taking notes on paper, that was really the only difference I saw until I got into looking for more websites that we could use. That took a few years to get going. I see some teachers still at just that point. Some teachers they use them a lot more

The teachers whom Teressa worked with still used the computers for the same tasks such as worksheets and note-taking they would have done on paper before the technology implementation.

A barrier John noticed in his classroom was communication with his students. He understood he could use the computers in order to share written directions or visuals with students. However, he personally preferred verbal communication. John said,

> Another thing is, I prefer to communicate verbally. Students are afraid of writing, so I prefer verbal communication. With regular kids it should be effective. Technology is more like learning through games that is the level of expectation.

Because John's personal preference was verbal communication and he felt his students who had special education needs had difficulty with reading and writing, he did not use the computer to effectively communicate. He had not used the discussion boards available for students to share ideas, and he did not often put instructions or other classroom management materials online because he felt the students could not understand them.

Personal-External

The second theme used to analyze the interview data was personal-external. Factors in the personal-external construct were those influencing individual teachers, but in which the teachers had little or no locus of control to change (Guskey & Passaro, 1994). Because teachers felt little control over external factors, these beliefs were often debilitating beliefs leading individual teachers to lower their efficacy towards instruction using technology. It was clear for these teachers these responses were areas of concern or frustration. The responses categorized into this theme included the term “I” or “me” when describing beliefs, but were ones the teachers were unable to change or impact.

The external locus of control within this theme created a negative attitude toward students and technology in general. The lack of control over external factors gave teachers the belief students could not use the technology appropriately or efficiently (Armor et al., 1976). Teachers felt a low locus of control because they felt they could not change the behaviors or policies leading to these external factors. The personal nature of the theme, however, indicated not all teachers had these same beliefs. These personal negative beliefs towards students or technology were not shared among all of the teachers in the study.

Teachers in the study indicated these factors were not possible to be changed. The administrator, Cindy, explained personal teacher beliefs were ones she felt were difficult to discuss because the teachers were stuck with their beliefs. Teacher behaviors in turn were in line with their beliefs as teachers with low expectations for students or technology were less likely to try to implement technology tools for meaningful instruction in the classroom.

Student technology confidence

Student technology confidence was an area in which teachers felt students either had a higher or lower level of computer confidence and competency than the teachers. This belief led to instructional choices as teachers were willing to allow students to use technology tools if they felt students could handle using the computers efficiently.

When teachers had a low level of confidence in the student technology knowledge, they were less likely to allow students to use computers in the classroom.

Technology confidence of students was rated higher than teacher confidence by each of the teachers except for John. Janet, Teressa, and Cindy all explained the students were more comfortable with the technology tools than the teachers. They all felt students were able to research, complete work, and work with digital files more quickly and efficiently than the teachers.

Teressa described how the students had more technology skills and confidence than the teaching staff in general:

> They are way above me, they are five steps ahead of me. Any time I have trouble, they can come in and fix it. They know more than they need to know. They are steps ahead and can figure stuff out faster than most teachers. For teachers who are a little unaware of what is happening behind the computers, it can actually hinder them. If you see the kids know exactly how to get games and flash drives, it just a different way to get distracted.

Teressa said it was not unusual for her to ask the students to teach her how to complete tasks on the computers because they learned how to use the tools from their previous teachers. However, her colleagues on the math team were unwilling to let the students' knowledge of computers assist them in working through technology troubles in the classroom.

Janet felt her students had the confidence to complete social media tasks and collaborative tasks quickly and efficiently. However, she felt these skills did not necessarily transfer over to curriculum tasks in math. Janet said,

> They need more skills for playing games than math. They need to know more for fun things. I've watched them make videos to place online. They made this video, but for my room, they need to use a stylus on a document. So I think they know a lot. They are good at it, but it doesn't transfer to math.

In order to capitalize on the student confidence in using technology tools, Janet would need to allow her students flexibility in using those tools in class. However, because she does not feel comfortable herself in utilizing social media or multimedia tools she does not allow her students to use them in class to demonstrate mathematics knowledge.

The only teacher who expressed the students were unable to use technology effectively and efficiently was John. He was concerned with the lack of preparation his students received in technology usage from their previous teachers, and this in turn caused the students to request to work on paper instead of online. He stated, "I just use hard copies. Students are more comfortable with hard copies, so I am transitioning to more of those." John explained students requested paper versions of assignments more often than completing them on the computer. No other teacher expressed these same concerns.

A recurring debilitating belief John described was the feeling his students were incapable of learning how to use the technology tools available to them in the classroom. He thought his students were not able to learn about how to use the tablet PCs for meaningful instruction because they were not taught how to use them starting at an early age. John said, "If they started using this tool in elementary, it would be a lot easier for us." He wished the students would have used the computers in elementary and middle school so they were ready to utilize the technology when they got to high school and started taking Algebra 1. Because of this belief, John would not use the computers for mathematics instruction, but instead did most of the class assignments on paper, printing worksheets for the students. He justified this instructional practice by saying the students preferred to work this way.

The other Algebra 1 teachers on the team at Northwest High School did not share John's debilitating belief in student use of the technology tools. The other teachers would teach the students how to use the computers and expected the students to learn the skills necessary to do so. In fact the other teachers described the students were more knowledgeable about how to use the computers than the teachers were because of the students' personal use of computers since an early age. Teressa said,

> They are more engaged as long as it is doing something different, not just doing the same thing they would have done without a computer. If they can see the real world application and the hands on part of it, then the teaching with technology is done appropriately.

The engagement Teressa described demonstrated the students came to school more willing and more able to utilize computers. John's external belief students were unable to use the computers was one John was not able to overcome or change.

Technology professional development

Training in the use of technology tools impacted the teachers personally as they learned to use computers both inside and outside of the classroom. The types of experiences teachers had with computers impacted the type of training needed in order to first learn how to use computers, and then apply that knowledge for personal use or classroom use. The teachers in the study related they felt a low locus of control as to the types and variety of professional development offered to them. They attended the training mandated by the school administration and did not feel they had a choice as to what they were able to attend or learn.

Initial use of the computers in the classroom was reflective of the types of training available at the start of the program. It was also reflective of the personal computer usage the teachers had before they attempted to implement the computers tools into the classroom. Janet described when she first started using the tablet computers, her students would simply complete the same worksheets they were used to doing before, but in a digital environment. She said,

> I remember having discussions with the team that I felt it was like electronic paper. I didn't understand how it was any different than having a physical textbook on your computer, with a sheet of textbook next to you writing on it. It just had an online textbook with digital paper they were writing on.

There was very little change in instructional delivery or collaboration between students. When asked about training for the initial use of the tablet computers, she noted the teachers were given specific training on how to use the physical machines. They learned how to turn them on, connect to the internet, and access the learning management system to assign work to students. However, there was no training available to teachers on how specifically to use the new technology tool for mathematical instruction. Janet described the training:

> When it came to the 1:1 laptops, I felt like I got a lot of information on how to do educational things, like how to post things on the learning management system, how to communicate with the students, maybe how to put a quiz on the website. But specifically for math, nothing that I can recall at all.

This was a frustration as she and the other math teachers wanted to utilize tools for instruction, but did not have the time to find and learn how to use the tools on their own.

Both John and Teressa described similar technology training when they first started using computers. John worked mainly with special needs students and found although he wanted to use the tablet computers to differentiate for the students in his class, there was no training available specifically for the use of the computer in this way. He described he had little math specific training and was left to find information on his own:

> Usually I see how other teachers are doing it. As of now, I wish I could find some tools that really encourage student engagement, but I haven't seen tools that really do that. I watch online videos, but they don't talk about how to do it. We need to teach, students need to learn. Wish they could provide practical modules.

Teressa knew from attending conferences, differentiation was a great way to use technology tools, but she was not specifically trained on how to utilize the computers for that purpose. The initial training for the 1:1 implementation was completely technology oriented. Teressa said, "it was more that I could pick and choose training. PowerPoint or spreadsheets or different things like that. It was more about dealing with numbers and data rather than working with kids in the classroom." Teressa said she would have liked more training specifically geared to Algebra 1 teachers utilizing the technology rather than generic training they were then to figure out how to implement.

Training continued to be an ongoing need of the teachers with regards to technology integration in the Algebra 1 classroom at Northwest High School. In order for professional development to be meaningful, it should be related to what the teachers are directly teaching (Wilfong, 2006). Job-embedded professional development would assist the teachers in seeing exactly how computer usage could improve the instructional delivery of mathematical concepts (Ertmer & Ottenbreit-Leftwich, 2010). However, the only training the teachers in the study referred to was for using the technology tools, not for instructional purposes. They received training on how to turn on the equipment, inventory the equipment, and take care of the equipment, but not how to teach with the equipment.

At the district level, Cindy explained the curriculum department and technology department had historically been separated. This divide between technology and curriculum created training on technology specific uses of the equipment instead of curriculum. She explained the rollout of the 1:1 program was done through the technology department, and had little curriculum involvement. The curriculum department trained on subject-specific instructional strategies, but not often including technology tools. Training specific only to the technology tool, but not related to mathematical concepts had not translated into computer usage at Northwest High School. Training in the future should be content-based, with technology tools integrated into the training so teachers see how they can use the tools for meaningful mathematical instruction.

Teaching-Internal

The third theme used to analyze the interview data for this study was teaching-internal. Teaching-internal factors were considered to be beliefs or influences teachers believed they had the immediate ability to impact (Guskey & Passaro, 1994). For the data categorized in this theme, there was a more positive outlook on the changes teachers felt they could make in the classroom because they could work as a team to make the changes needed to incorporate technology tools. The locus of control for teaching-internal factors was close to the teacher's ability to make change in his or her own classroom, and in the larger context of the Algebra 1 team or school-wide instructional program.

Differentiating between personal and teaching factors was an important distinction when analyzing the efficacy of teachers towards instructional tasks and tool (Guskey & Passaro, 1994). Although teachers may have felt personally efficacious towards using technology, the efficacy towards using technology for meaningful instructional tasks in the classroom may have been quite different. Personal efficacy may impact teaching efficacy, but the two are not necessarily related. In the data collected for this study, the teachers who had a personal efficacy towards technology tended to be more willing to incorporate technology into the classroom. However, those teachers still felt cautious when using technology tools specifically for math instruction. The comfort level of personal technology use tended to impact the comfort of teaching with technology. But the specific math instruction did not seem to be impacted by personal technology efficacy.

Data from interviews including the term “we” or “us” were categorized into the teaching themes. The teaching themes were differentiated from the personal themes because teachers as a group learned from each other and incorporated lessons or technology into their classrooms. In developing math lessons specifically utilizing technology, teachers as a group may have felt a greater collective efficacy doing the work together instead of in isolation.

Of the data categorized into the teaching-internal theme were those interview data and observation data close to the teachers’ locus of control. The close locus of control in the internal themes means teachers felt greater efficacy in making substantial changes to the classroom or environment to make a difference in how they taught using technology tools.

Technology instructional choices

Teacher lesson plans had a direct impact on how technology was used for instruction in individual classrooms. How teachers chose to implement technology tools within their individual lessons impacted how mathematics was taught and the focus of mathematical rigor in the classroom (NCTM, 2000). Choice of the teacher on how to implement the integration of computers and software into instruction meant varying levels of technology usage was observed at Northwest. Teachers had a high level of control in how the technology was used because they wrote the lesson plans and planned the activities students will be doing during class. Overall, a low level of student engagement was observed in the classroom as far as the interaction with the technology was concerned. The students were observed using the stylus to complete digital worksheets. The teachers all referred to this as “paper under glass.” It was appreciated the computers had a stylus, but the teachers still felt the resources available limited what could be done on the computer.

The teachers described technology tools other than the computer that would help students understand mathematical content better and more efficiently. The graphing calculator was a tool the teachers consistently mentioned was a tool they could rely on to help students visualize and understand mathematical content. Teressa appreciated using the graphing calculators more than the computers because of the types of resources available specifically for Algebra 1. She said,

> The calculators are technology. We use those on a daily basis. That is definitely a much bigger component and necessity in the classroom than even the computers are. We would much rather invest our money in the graphing calculators than in anything computer wise. It’s getting the biggest bang for the buck in Algebra 1. They have made a huge difference. They are more user friendly. The math terminology is in there, it’s not hidden in key strokes.

Teressa and the other teachers felt more comfortable using graphing calculators because they had used calculators themselves longer than the tablet computer and could easily adapt questions or activities to the state standards and classroom needs. This impacted the level of computer use because they would spend more class time using calculators instead of computers.

Professional learning communities

Teacher learning and collaboration were important facets in the Professional Learning Communities (PLC) at Northwest High School. The PLC process was a structured planning process in which teachers asked themselves fundamental questions about what students should learn, how the teachers would assess understanding, and what actions would take place when students did not show mastery of content (Eaker, DuFour, & DuFour, 2002). The PLC framework directly related to the teaching taking place in the classroom because teachers planned together the instructional strategies they would use in the classroom. They also learned from each other during the process which may have impacted the efficacy with which teachers faced the instruction of students (Morris & Thrasher, 2009). As a team of teachers working together at Northwest High School, the PLC was a tool used to uncover challenges and discover solutions. Collectively, the teachers and administrator in the study pointed to the PLC as a place where teachers could share both positive and negative aspects of the 1:1 implementation and work to provide answers and solutions.

At the same time as the new technology tools arrived in the campus, PLCs also were starting to be implemented at the campus. Cindy said her responsibility as administrator was to ensure the teachers were meeting regularly to discuss the instructional needs of students as part of the PLC process. Cindy said the teachers appreciate this time to collaborate and discuss the instructional methods used in class, especially with the use of the computers. She can share positive and negative aspects of implementation with teachers to start a conversation. Cindy explained,

> If I see something good I will praise it. It's a great reminder of the positives when we go the PLC and bring it up in front of the whole group. It jars that conversation. If technology is used incorrectly, then that's a conversation to have to understand why they are doing that.

Teachers took this opportunity to share resources and small successes in their classrooms with each other. This time was especially necessary because the teachers were not being given specific training on the mathematical instruction using computers in the classroom.

The PLC process continued at Northwest High School and all three teachers interviewed had opinions on how the collaboration time helped them with regards to teaching and technology use. Janet did not meet with the Algebra 1 PLC on a regular basis because she had a class during the time the rest of the group met. She found meeting with the rest of the group did not benefit her because she taught the advanced students and did not see the need to collaborate with the teachers of the on-level classes.

Teressa utilized the PLC time to share ideas and learn from the rest of the team. She said,

> The PLC is where it is a good time to bring in software and show how I'm using it. Show exactly how I'm using it in the class. That's where we get buy in from the teachers, when those teachers who are using it all the time demonstrate how they use it, and trouble shoot those issues. So to be able to have that time in the PLC, go through it as a team, to make sure it meets the standards, that helps to get everybody on the same page.

Teressa described at the beginning of the school year the PLC time was typically spent calendaring out lessons or writing assessments. The Algebra 1 team took time in December to plan out the second semester lessons and assessments which has provided them with more time in the spring to focus on instructional strategies during the PLC time and sharing out technology resources and use.

Teressa described the Algebra 1 PLC as a team who collectively sought and shared best teaching ideas for Algebra 1. They would each bring ideas for how to use the technology and together create a calendar and plan for implementing those ideas. The PLC discussions were overall positive one as teachers worked together to find solutions. Cindy said as the administrator in charge of making sure the PLC discussions were taking place, she had to build time into the calendar and then lead the type of discussions the teachers were having. One of the positive aspects of PLC planning was the district provided additional teaching staff so each Algebra 1 teacher was able to have a planning period during every day to meet and collaborate to share ideas. This time had become invaluable to all members of the team except for Janet who was unable to join the team because she had a class scheduled during that time.

The collective efficacy of the team was most highlighted during this PLC time. The individual teacher was more likely to grow because the team was more willing to try new ideas together. The fear of failing alone was taken away. Teressa said if they work together, and an idea does not work out in the classroom the way they had hoped, then they knew together they could find a solution. This notion of collective efficacy built off of each teacher's self-efficacy as the PLC had become a way to provide informal professional development (Bandura, Barbaranelli, Vittorio Caprara, & Pastorelli, 1996; Watson, 2006). Cindy described situations in which the PLC process allowed teachers to share creative ideas and learn from each other. She said,

> We want the teachers to spark and lead the conversation. They find great lessons, and they share with their colleagues to see that it works. So much of the resistance to using technology is that it's not going to work, so why try? The teachers are afraid to fail. They know what they are doing is not perfect, but it's gotten them so far.

Time for sharing creative and useful tasks for Algebra 1 would allow the teachers to build efficacy by learning vicariously from each other.

Teachers on the Algebra 1 team were also looking to gather vicarious experiences from each other in order to build their efficacy towards using technology tools in the classroom (Guskey, 1986). Teressa described she would model classroom instruction for other teachers in order for them to see her using instructional strategies and technology tools with students in the classroom. This coaching model had been positive, according to Cindy, because the teachers saw the strategy or tool being used in a positive way and the excuse the training was not done with an Algebra 1 context was taken away. However, Cindy would like to use more coaching in the classroom for professional development:

> I know modeling is not as formal as a training. Teressa goes in and works with new teachers, they do lesson planning together. She does model lessons to show them technology. Does she create a lesson and present it to the entire team? No. That's my fault for not asking her to do that.

Utilizing a coaching model could impact teacher effectiveness by providing real-time professional development within the teacher's own classroom (Wang, Ertmer, & Newby, 2004). Teachers seemed to be more likely to implement something once they saw a specialist or instructional coach have success with their own students (Guskey & Passaro, 1994).

Teacher preparation programs

Early experiences through teacher preparation programs tended to have an impact on the efficacy of teachers, particularly in attitudes towards children and control (Hoy & Woolfolk, 1990). Understanding the types of early training the teachers in the study had regarding technology may assist in understanding why they choose different technology tools or instructional strategies to use in the classroom.

Teacher preparation programs varied for the teachers in the current study. Specifically, John did not go through a traditional university teacher preparation program, but instead though an alternative preparation program which did not provide him with student teaching experiences. John did not learn positive experiences from students from either teacher preparation programs or early student teaching experiences. He felt he had little control over what students could do with technology as it related to Algebra 1. His self-efficacy towards using technology for instructional purposes may have been negatively impacted by his lack of early exposure to positive role models through student teaching.

Janet's teacher preparation program in college included an instructional technology course. However, the course which occurred in the late 1990s was limited in scope to using audio tapes, showing film strips, and creating slide shows for presentations. She was not asked as part of her teacher preparation program to integrate technology tools into instruction. Janet explained her technology course:

> I sat in a room with stations. One of the stations was an opaque projector. You could choose a book and put it under, project and trace it. Then you moved to the next station, which was putting a tape in a tape deck, listening to it, then filling out a little blurb on it. There was one station where you actually had to use a slide projector. The most technological station of the whole thing was a station with a computer that showed me how to do a PowerPoint. And it showed me how to insert a link and all that kind of stuff. It ran me through it, but I didn't get anything out of it.

The other teachers in the current study had positive teacher preparation programs, although those programs were lacking with regards to technology. Those teachers did not express concern over what the students could do with technology, but what they themselves could do to teach with technology. Teacher preparation programs specifically geared toward technology integration may help support teachers who are entering a work force where technology usage is not optional, but required for implementation of the curriculum. Teacher preparation programs specifically including technology integration supported teachers in their personal use of technology for productivity which led to the access and use of electronic resources for instruction (Ottenbreit-Leftwich et al., 2012). The teachers in the current study went through teacher preparation programs before computer integration was expected in the classroom. Administrators should take this into account when developing professional development activities to ensure veteran teachers without technology preparation program, new teachers with technology preparation programs, and alternatively certified teachers without technology preparation programs are all considered.

Teaching-External

The fourth theme used to analyze study data was teaching-external. The factors categorized in the teaching-external theme were ones directly rated with the teaching of mathematics using technology, but ones in which the teachers felt they had little control to change (Guskey & Passaro, 1994). It was clear from the interviews the discussions categorized in this theme were the most frustrating and debilitating for the teachers. There was a negative view of the issues due to the low level of control teachers had in this area. As a group, they had been unable to overcome these issues, so debilitating beliefs often fell into this category.

Teaching efficacy factors were influenced by the group of Algebra 1 teachers working as a team on the work of planning lessons and activities for students. Data categorized into the teaching themes included the words “we” or “us” as the group collectively worked to implement technology into the math classroom. The efficacy of the group impacted the individual teachers as they worked to implement lessons in their classrooms and incorporate technology tools into meaningful math instruction.

More interview data was categorized into the teaching-external theme than any of the other themes. Even though interviews were done individually with teachers, they often talked about the Algebra 1 team and the work they did together rather than their individual classroom. Teachers in the interviews also seemed to dwell on the negative aspects of technology integration they could not change. From the teachers it was evident they had discussed these issues as a team before, but were unable to find solutions. Observations in the PLC meetings also supported the debilitating beliefs found here because they discussed these same issues as a group, but did not have quick solutions.

Teaching-external factors impacted efficacy towards technology usage because the locus of control for these factors was removed from the teachers’ influence. These were beliefs or behaviors in which the teachers feel little control to change or impact. These barriers could impact efficacy because the teachers learned to deal with factors from school practice or policy impacting the work they do in the classroom. Without an understanding how they could change the barriers around them, these external factors led to lower efficacy towards teaching (Armor et al., 1976).

Expectations of technology usage

Expectations from administrators and parents on how Algebra 1 should be taught and assessed was a teaching-external factor that was a common barrier among the teachers. John explained he felt the administrators at Northwest wanted the teachers to all be teaching the same way. Therefore, the teachers stuck with a traditional teaching methodology for this reason. If they kept teaching the same things, in the same instructional methods, then the administrators would not be upset. Teressa said the parents expected certain activities, worksheets, and grades to be presented to students so the parents could track their progress. Changing the types of assignments and grades would not be welcome from parents who expected the classroom setup to be similar to the way they themselves were taught in school.

Initial use of the computers was mandated by the administrators to get teachers started using the computers in class. It was an expectation teachers would use the computers during every class period every day. Cindy explained the administrators needed to make this mandate because students would not bring their computers to class if the teachers were not using them. The teachers who were expecting for the students to have their computers were frustrated the students did not have the tools and the other teachers were not using the same expectations. Cindy explained,

> Another thing we found with the laptops, was that we had to force the teachers into using them every day, just so the students would show up with the laptops. At the beginning, not a whole year, teachers would get frustrated. They would tell the students they were using them tomorrow, but who wants to lug around a

> laptop when they don't have to? Then students didn't have their supplies. We had to force the issue that they had to use them every day. Then that issue went away and the students did have their supplies.

A campus-wide expectation of usage was necessary in order for the teachers to get started, and for the students to bring their computers to class every day. With help from the administrators, the teachers were able to overcome this external barrier to implementation.

Mathematics technology resources

A lack of resources to teach mathematical content on the computers was a barrier voice by the teachers in the study. They either did not feel they had the resources provided to them, or they were not confident in choosing their own resources to use online. In certain instances, the lack of technology-based math resources meant going back to traditional teaching methods.

Teressa voiced a concern the computer was not always the best way to present mathematical information to students. In certain circumstances, she felt the students needed hands on materials and experiences. She explained,

> We don't mind if they use the computers every day as long as it's beneficial. If it's easier for kids to use scissors and cut manipulatives out of paper, then let's put the computers on the floor, get out the paper, and get the manipulatives in our hands. Rather than watching somebody on the computer screen doing it. It's important to know when to use it and when not to use it.

Traditional methods of using manipulatives to teach math concepts was so important to Teressa that she was observed having students put away technology and use hands on resources instead. She would prefer students had a hands-on experience rather than watch a video or simulation online.

The lack of resources to teach mathematical concepts using the tablet computers was a barrier to full implementation of curriculum on the computer. Janet described how the math resources on the computer were limited to webpages, textbook pages, and a few interactive activities. One activity Janet described was an interactive website where students could drag a line graphed on a coordinate plane and see the slope changing dynamically on the screen. She explained its use:

> For example with the website you could move the line to see how the slope changed, and the slope would be decimals not fractions. And we had spent all that time talking about rise over run to explain slope as fractions. Obviously that should be ok for the students to convert between fractions and decimals, but at the time of just introducing it and just learning it, it confused them. So a really great activity we just scrapped. It actually did more harm than good we felt like.

Although she said the Algebra 1 team was originally excited about using this interactive website, the activity did not meet the standards as they had hoped. While the activity was good, and the students understood how to translate between fractions and decimals, the extra step put a barrier in place for when the students needed to understand the fractional components of slope.

Differentiation of student processes

The process by which teachers meet students at their individual level of instruction and scaffold them all forward to mastery experiences is differentiation (Van de Walle et al., 2010). Technology tools can be used to differentiate for students in a 1:1 classroom because each student has access to a variety of resources the teacher can customize to the individual level of learning needs (Dunleavy & Heinecke, 2008). Collaboration tools available in the learning management system can also allow teachers to set up discussion boards and work groups of students at different levels of mathematical understanding. The teachers in the study felt a low level of control in differentiation because of the lack of training and level of knowledge of the students in using the available tools.

As far as differentiating for the needs of students, John felt his struggling students would have difficulty with interactive activities on mathematics websites. He felt the activities on the websites assumed students would have some basic understanding of fractions, slope, and lines before the students were to interact with them. John explained,

> One program we like to use whenever they have modules for Algebra is an online simulation website. But I realize that when you teach linear functions, the students need to grasp concept of a function, then you introduce x and y, graph a line. But the website doesn't have enough of that early information. We try to collect whatever was related and scaffold, but somehow the concepts are not connected. By my standard it should be more helpful.

When students were in John's class, he said they often were below grade level and he felt students would not have the basic knowledge from prior grade levels to understand the interactive activities. Scaffolding the students up to the knowledge level required to run the activities or simulations would take additional time he felt he did not have in the classroom.

A learning management system in which students were assigned different lessons and collaborated on work allowed teachers to differentiate for each student's individual needs or learning style. The teachers felt the differentiation of the classroom using technology should be a benefit of every student having access to a computer. John felt his students were unable to use the computer's learning management system for much interactive work, limiting the differentiation he was hoping to do. John explained about the learning management system:

> It should be the case when students feel comfortable, differentiation should be easier. For instance, time wise. They actually catch and have easier focus. After we put out worksheets on the learning management system, they can use different colors. Often we realize some of the students are autistic, they don't have tolerance, and get agitated. I want to use more technology, but I talked with the math specialist. If they feel more comfortable with hard copies I let them.

John said his students would often ask for paper assignments instead of online assignments because they felt more comfortable with traditional physical assignments and would not know how to navigate the learning management system. His students would lose digital files they would download and never be able to turn in for a grade.

Due to these barriers, John developed a lecture teaching style with little student differentiation.

The Algebra 1 teachers at Northwest found some online tools over the years that allowed students to learn at a different pace. Teressa used the online tools to differentiate in certain ways:

> It lets us teachers not teach everybody the same thing at the same time in the same way and the same amount of time. There are so many gaps from different places, it's difficult to keep the kids up with what they need when there are things hindering them.

Teressa explained certain online programs allowed her and the other teachers to differentiate for specific students and fill gaps in knowledge. She said,

> There are a lot of good programs that do quick feedback, which is nice. It's not homogeneous, it's not all the kids getting the same question. It gives them a question, and based on how they do, it gives the next question whether they take a step back or a step forward. And that's really neat to see in the classroom where each kid can go in a different direction, get what they need, and fill in those gaps. If it's a multiple choice question with distractors, it not only tells them they got it wrong, it also tells them what they did wrong. They picked specific distractors for specific reasons. The kids are getting immediate feedback of what they did wrong, how they can fix it, and then get a new problem similar, but not the same. That is the neat thing with the software developed over the past ten years to generate the individual work.

Utilizing new technologies to formatively assess students and allow them to fill gaps in knowledge meant Teressa had differentiated for student learning in a new way using the computers.

The collaboration tools on the learning management system was an area in which Teressa had not explored the usage in Algebra 1. She said, “any collaboration is kids sitting in groups working on one computer.” Teressa felt she did not have sufficient training in order to implement the tools. She would have liked to understand how students would be able to communicate their understanding of mathematics content so she could then differentiate for the students based on their individual needs. Unfortunately, according to Teressa, the training she received on the learning management system had been done using other content areas instead of math and she struggled to see how she could apply this method to her Algebra 1 classroom.

John did not explore the collaboration tools available in the learning management system as he felt the time needed to learn them and train the students was not worth the effort. He stated, “we haven’t used that. We haven’t gotten to it. I know it’s available, but we haven’t tried to use it. It should be that way. It seems like I’m a bad teacher.” John requested students would learn more about the learning management system in elementary or middle school so they would be prepared to use the system once they got to high school.

Subject specific professional development

When implementing a change in instruction, whether it is a new instructional strategy or instructional tool, teachers need to build efficacy in their ability to implement the change. One way to build efficacy in change is to ensure teachers have mastery experiences utilizing the new strategy or tool (Guskey, 1986). In order to provide teachers with mastery experiences in the change process, Guskey (1986) suggests initial professional development should be subject specific in order to be easily implemented by the teachers. If the teachers have specific lessons they can use in their classroom, then they are more likely to build mastery experiences with their students, which in turn builds efficacy towards the change.

Initial training for the use of computers in the classroom at Northwest High School was handled by instructional specialists who focused solely on technology integration rather than mathematics content. As the administrator who assisted in planning the training, Cindy explained this method was chosen because the initial training needed to be for the teachers to know how to use the equipment, and then the teachers would be responsible for inserting their individual content. The choice and type of initial computer training was described by Cindy:

> The initial training wasn't adjusted for teachers of different content. It was just a matter of presenting the tool. Here's the laptop, here's how you use it. They did get their laptops a year earlier than the students in order to practice and learn how to use them, but it didn't clue in until the students had their laptops. Now what do we do with it? It was a round of training, but it wasn't an everyday thing yet. It wasn't until the students had the laptops. Scrambling. It was like every teacher was a first teacher again because it was so different.

Technology specific training instead of content specific training was chosen by Cindy and the other administrators because they felt teachers first needed to know how to use the equipment. They were confident the teachers would be able to adjust the information to include content specific information. However, Cindy realized the teachers had a difficult time making that shift.

Janet expressed frustration of the teachers who did not have the time to reflect on the training and insert content specific material before the implementation of the initiative:

> After the initial training, we didn't get many math resources. Right now I don't feel like I have a lot of good resources. Maybe they are somewhere in the district, but I don't feel like I have that. I've had to go look for a lot of stuff. Another hazard, when you discover a need, the process for finding a resource, getting it approved, that's a barrier as well.

This selection of training may have led to low levels of mathematical integration into the technology usage and may have caused the lack of higher level collaboration tools used in the Algebra 1 classrooms. By building mathematics resources into the training, Janet and the other Algebra 1 teachers would have been able to implement the change in instructional tools sooner, with more efficacy in the process.

A tool available to the teachers and students for use in the classroom was a learning management system. This system allowed the teacher to have a virtual classroom where each student could access documents, turn in assignments, receive grades, take part in discussion boards, and take online quizzes or tests. The teachers described the use of the learning management system at the basic level, and had not gone much beyond assigning worksheets for the students to complete on the computer and turn in for the teacher to grade.

Janet described the learning management system as a way to go paperless as the teachers and students could hand work back and forth digitally instead of printing and using physical paper. However, the work the students were doing on the learning management system was the same as they had been doing prior to the implementation of the 1:1 program. The Algebra 1 teachers had not used the discussion boards or online assessment tools in the system. Teressa said this was because the teachers had not been trained on how to use the discussion board for mathematical discussions. She explained, "we never had any training math specific. I don't know if we've ever had anything about math." They had been shown the discussion board in generic training, but integrating with mathematics was left up the teachers and they did not have time to explore more.

Cindy explained the teachers did not use the collaboration tools in the learning management system because the training involved was not subject specific. As the administrator overseeing curriculum, she scheduled training for the teachers on the use of technology. However, she struggled with finding subject specific training because the training offered by the company or specialists typically was more generic. Cindy said,

> Teachers asked for technology training. How much more can we give them? One thing that came up is that we are not seeing as much of the learning

> management system discussion boards for collaboration. I don't know if it's still new, or if the teachers are not comfortable.

Cindy scheduled training where teachers were asked to share their successes with technology with each other. This type of training was beneficial as the teachers enjoyed it, but because few teachers on the campus had spent time learning the collaboration tools on the learning management system, no teachers were available to train and share their success stories.

Grading policies that interfere with implementation

When the teachers first implemented the 1:1 computer initiative, the school did not change policies that may have either helped or hindered the implementation. One policy mentioned by the Algebra 1 teachers was the grading policy. With a shift in instructional practice, they felt a barrier because the instructional strategies they were asked to implement were not in line with how grades had to be completed.

When asked if the students were allowed to demonstrate their knowledge of the mathematical concepts using their technology tool of choice, the teachers explained this was not an option. When asked if she had ever allowed students to choose how they turn in work using technology tools, Janet explained:

> No I haven't. The minute you say that I get all crawly. How do you grade something like that? A lot of things like that have to be checked over, you have to sign off on it, and I have to say I can see you understand that. In our current system, people want that feedback in a grade. How do I compare a video with a student who drew me a picture? That variety freaks me out a little bit.

> Everything we've been taught to assess has been used with a rubric. In my opinion, I know what you're doing. But it's so subjective. We've been talking a lot about that, what do you really know? We've had a lot of discussions about that. You want to tell a student you did all that work and you did a great job. How do you give partial credit for that? It's very difficult to assess knowledge and learning.

Janet was adamant it would not be possible to allow students flexibility in turning in work through a video, website, slide show, or some other productivity tool because it would be too difficult to grade. The grading would be too time-consuming and subjective in order to provide valid and reliable feedback within the current campus grading policy. She realized a rubric would be used to grade these projects, but it would be too subjective across her class and across the Algebra 1 team for the teachers to be able to justify grades to administrators and parents should there be any questions.

The time necessary to develop new lessons and grading rubrics allowing students to explore and be more creative were a barrier for Teressa. She explained,

> Giving kids choices is a great thing. But if you make a project, taking two days in class, I don't know. It would take a lot of work in the front end to make sure it hit everything and I'm not sure it's worth the time.

Because she and the other teachers were unwilling to prepare lessons that allowed students flexibility, the majority of instructional time was teacher-directed. The teachers explained all student work was teacher directed as well, with specific guidelines for what program to use and how to complete the work.

The grading policy had not changed at Northwest High School since the implementation of 1:1 computing and so the teachers felt like they were stuck with assigning the same types of worksheets, quizzes, and tests they had always given. Cindy said it was the teachers' comfort zone with the grading policy that kept them from asking administrators for a change, but the teachers stated they felt it was not their place to ask. Teressa said it never occurred to her to ask for a change in grading policy that would allow them to utilize other technology grades because it was set that way for so long.

Student distraction caused by technology access

Negative aspects of the 1:1 implementation were mentioned from several of the teachers that impacted their efficacy in moving forward with integrating technology tools. The largest of the concerns was the fact students would become distracted by the tablet PCs during class time and so the use of computers interfered with instruction. John stated this distraction of students, where they would play games or surf websites instead of completing math work, caused him to move back to a more paper-based environment. He explained, "they could do something other than what they are supposed to." Fear of student distraction kept him from using technology tools on a regular basis.

Janet described times when she would have to ask the students to put away the computers because they were too distracted to listen to her describing math work. Janet said,

> In the actual classroom, the technology can be distracting. It's the elephant in the room. Even adults become distracted with technology. We've had students

> refuse to use the computer because they know they will become distracted if they turn it on.

Although the school administration required use of laptops in the classroom on a daily basis, Janet said she sometimes would require the students to put them away to get math work done. When students were playing games or searching on websites, she was unable to get math instruction done within the class period.

Student distraction was a negative barrier the teachers felt powerless to control because the administration expected the students to use the computers in every class, every day. Teressa said this expectation from the administrators was good to start with because it forced the issue of teachers integrating technology. However, she also said the teachers felt they had to allow the students to have their tablet PCs on the desk and on even if the use of them was not appropriate for the lesson of the day. Teressa explained frustration in the student distraction:

> Teachers who are good can see just from the look in the kid's eyes if they are playing games or paying attention. Some teachers can't, they need more structure. It's a different way to teach, assess, and keep kids on task. There are a million things for kids to become distracted, it's just not passing a note in the middle of class. Its texting and emailing and having five computer windows open. It has to be a different way of monitoring. Even if there are a ton of great things about the computers, there are also a ton of ways to get distracted

Having the computers turned on meant students were distracted and likely to play games instead of pay attention to the teachers.

Summary

Throughout this study, teachers expressed efficacy factors falling into one of four categories: personal-internal, personal-external, teaching-internal, and teaching-external (Guskey & Passaro, 1994). The teachers in the study were asked to share their personal use of computers because the use of computers for personal tasks and productivity impact the efficacy with which teachers face teaching tasks in the classroom (Cuban et al., 2001). The locus of control with which teachers felt towards the barriers also impact the efficacy towards the implementation of technology integration into the classroom (Armor et al., 1976). By analyzing the factors in each of the four categories as described in the efficacy theory, findings were interpreted to understand how these factors impacted the efficacy of teachers toward using technology tools in the classroom.

Bandura (1997) explains mastery experiences lead to efficacy for teachers who are attempting to implement new initiatives or instructional practices. If teachers have early successful experiences, then they will continue to strive to replicate those experiences by continuing to implement the change. By connecting the success of the new implementation to the success of students, the teachers develop efficacy in their work. Administrators can facilitate this efficacy growth by ensuring teachers have these early mastery experiences. First, administrators must ensure teachers are using the new instructional practices. Second, they must ensure teachers connect the success of the students to the new practice. By building efficacy in this way, administrators can help increase the likelihood of the implementation of new practices.

In the absence of mastery experiences, vicarious experiences can be utilized to build efficacy (Bandura, 1997). Early implementation of new practices, such as the 1:1 initiative at Northwest High School may require teachers to observe others using the tools for meaningful instruction and observe success from other teachers. A visit to another school utilizing the same technology would help build efficacy through these vicarious experiences. As new teachers join the Algebra 1 team, as John has recently done, a mentor teacher should be assigned to share these vicarious experiences to build efficacy for the new teachers. Administrators should lead the charge of ensuring all teachers have mastery or vicarious experiences to build efficacy if instructional change is to occur.

The understanding of how the change process can be managed through professional development is important when implementing new initiatives. Gaining a sense of commitment from teachers first can help them earn trust and belief the initiative is worth pursuing (Guskey, 1986). Because efficacy is related to the beliefs teachers have regarding the change in instructional practices (Bandura, 1977), building a sense of trust and commitment as part of professional development is important. The teachers at Northwest High School did not have a sense of commitment and belief the 1:1 implementation would work because they did not have good models specifically related to their content area. Administrators providing models in different content areas, specifically Algebra 1, would have provided these early learning experiences and built commitment to the change process.

The change process starts by understanding a change in beliefs often occurs after the initial implementation phase and teachers have some sense of success (Guskey, 1986). Guskey suggests small, incremental changes can be used initially to build trust and mastery experiences. The teachers at Northwest High School started small by having goals to use the computers daily and use webpages for interactive activities. However, the initiative did not move forward from here to more engaging and collaborative efforts by students on the learning management system. Administrators can help move teachers past initial implementation by giving regular feedback and highlighting successful classroom practices (Guskey, 1986). Ensuring teachers have positive experiences from the start with new resources and tools such as the tablet PCs would assist with increasing efficacy in using those devices in the future (Morris & Thrasher, 2009).

Building belief in the change process can be supported by ensuring the people providing the professional development are seen as credible by those responsible for implementing the change (Guskey, 1986). Because early training at Northwest High School focused on non-subject specific technology usage, the teachers did not find the training useful or credible for their classroom. Training performed by instructional specialists focused on mathematics content may have led to a higher level of implementation because those specialists would have been able to insert mathematics content into the training, therefore making the training credible. Training integrated into the content area tends to assist teachers with implementing new instructional strategies or using new instructional resources because they can see clearly how it relates to their classroom (Paraskeva et al., 2008). Early successes from professional development deemed as credible may have helped build efficacy from the start, increasing technology implementation.

External factors in which the teachers feel powerless to make changes negatively impact the efficacy with which they face using technology tools in the classroom (Guskey & Passaro, 1994). When barriers are put in place the teachers feel they cannot change, they feel it is not worth the effort to ask for change. Negative expectations of students are also ways in which the teachers collectively position themselves to bar change.

When asked how they would solve issues in the external construct, the teachers offered few solutions. It seemed to be a learned helplessness from the group collectively deciding they were unable to affect change in these areas. They would not offer solutions to grading policies negatively impacted technology integration. They also felt there was no solution to student distraction, and they would simply have to put up with it and hope the students would eventually pay attention enough to be successful. Additional barriers in the form of time to learn new tools and strategies, lack of technical support, and lack of parental understanding of the technology tools were external factors which the teachers felt impacted their work.

The results of this study show barriers exist at Northwest High School both to the integration of technology usage in Algebra 1 classrooms, and to the self-efficacy of teachers in using the technology. Overall, the usage of the tablet PCs for meaningful mathematics instruction is low even after seven years of implementation in the classrooms. Teachers are not able to find resources, training, and time to implement the technology integration in the way they would prefer. Self-efficacy in the use of technology for personal tasks is high, with teachers using technology for productivity tools. However, efficacy for using technology integrated with mathematics teaching is low because of barriers the teachers see as beyond their locus of control.

Administrators at Northwest High School have done a commendable job in ensuring students have access to technology tools and that the tools are brought with them to class every day. This barrier to access and equity is not an excuse for low implementation of technology integration. However, the professional development offered to teachers has been non-specific and generic. This has not allowed for the mastery and vicarious experiences necessary for teachers to build efficacy using technology for meaningful integration in classroom instruction.

CHAPTER V

CONCLUSIONS

In the previous chapter, the results of the current study were presented and analyzed to give an overall picture of the self-efficacy towards usage of technology tools in Algebra 1 for the teachers in the study. This chapter will synthesize the results of the study and provide recommendations for practice. Limitations of the study will be shared as well as recommendations for future study.

Summary of Findings

The purpose of this study was to analyze the impact self-efficacy has on the integration of 1:1 technology tools in Algebra 1 classrooms. In order to provide the findings on self-efficacy within the larger context of the 1:1 implementation, the findings were categorized into a priori themes surrounding the personal and teaching efficacy of teachers (Guskey & Passaro, 1994).

Northwest High School utilized 1:1 computing using tablet PCs for seven years. Students at the school check out a computer to use at school and at home for the entirety of the school year for academic purposes. The initial implementation was mixed, with students not regularly bringing the computers to school. This limited the initial mastery experiences and success teachers were able to achieve. Initial mastery experiences when implementing change are key to building efficacy (Bandura, 1997). After school administration monitored teacher usage of computers in the classroom, student use had increased over the years. Initial professional development for teachers centered on usage of the computers themselves rather than using computers for academic purposes within an Algebra 1 context. This hampered the teachers' ability to implement meaningful usage early on in the implementation, and seems to have negatively impacted the efficacy during the length of the implementation. Building vicarious experiences early in the implementation would have helped teachers build early efficacy in their use of technology (Guskey, 1986).

Computer integration at Northwest High School was commendable due to the equity and access with which students had technology tools for learning. Teachers utilized the computers primarily for productivity tasks, formative assessments, and sharing grades and information. This was a typical finding from the research as technology integration is slow to develop (Warschauer, 2006). Although teachers had access to communication and collaboration tools, they were rarely used in the classroom. Teachers did not share confidence in their ability to utilize tools for mathematics and collaboration in the classroom which related to the efficacy with which they were willing to implement new technology tools. Providing initial professional development in using the technology specifically for Algebra 1 classrooms would have helped teachers in building efficacy and therefore usage of the computers (Warschauer, 2006).

Algebra tools and resources for the 1:1 computing implementation seemed to be limited for the teachers. This impacted their ability to utilize technology for the visualization and practice required to master Algebra 1 content. Teachers spent some time creating activities, but did not have the efficacy in creating and implementing technology activities without full understanding of the programming involved. Teachers were much more willing to implement graphing calculators for instruction and did so with ease due to the training made available for the tools and the activities specific to Algebra 1 written into the district curriculum. Because 1:1 technology in the classrooms was a new venture at the time of initial implementation, particular care should have been taken to provide resources and training (Godsall et al., 2005).

Teacher confidence related to the self-efficacy they felt in utilizing the computers for instruction. The teachers felt confident in using computers for productivity tasks such as e-mail and recording grades. However, the confidence level in using computers for instruction was lower, due to the lack of mastery experiences. The teachers felt students had a higher level of confidence overall, and some were willing to leverage the student confidence in the classroom to allow the students to utilize the computers for instructional purposes. However, the teachers still seemed unwilling to let go of control of the classroom instruction and turn over the accountability for learning to the students. It would have been helpful for teachers to let go control of the technology tools and allow students to do the work as they saw fit with the tools the students were more comfortable with at the time (Baltus, 2010).

Locus of control related to self-efficacy because barriers which had an internal locus of control were more likely to raise efficacy than those factors with external locus of control. Teachers were able to overcome the barriers with internal locus of control, including personal use of computers and sharing vicarious experiences of success. Barriers with an external locus of control still hampered the implementation of technology usage (Armor et al., 1976). Time and resources were two areas in which teachers felt they did not have the efficacy with which to make lasting changes in instructional practice. Negative views of students and their ability to use computers still hampered the efficacy of some teachers to utilize the tools. Barriers such as outdated grading policies and student distraction also seemed to cause teachers to feel lower efficacy towards using technology because they felt they could not make lasting changes to these barriers.

Recommendations for Practice

The research questions for this study related to the feelings of efficacy teachers have towards using technology tools in Algebra 1 and determining what administrators and teachers can do to increase the efficacy towards utilizing technology tools for meaningful instruction. The findings highlighted a need to increase certain aspects of professional development, resources, and time for mastery experiences so teachers could increase their self-efficacy towards using 1:1 technology in Algebra 1.

The professional development offered to the teachers in the present study was primarily non-subject specific and centered on technical issues of using and maintaining computers or software. While this training was necessary at the beginning of the implementation for teachers to understand the tools themselves, it did little to help teachers build efficacy towards using the tablet PCs for mathematics instruction. In order for training to be more effective in increasing self-efficacy towards a new initiative, the training should be specific to the subject area (Guskey, 1986). Ongoing, job-embedded professional development is helpful for teachers who are implementing a new initiative such as 1:1 computing (Ertmer & Ottenbreit-Leftwich, 2010). The teachers in the study received initial training from specialists who focused on technology integration, but were not knowledgeable of Algebra 1 content. By ensuring training and coaching is implemented by specialists knowledgeable in Algebra 1, this would help teachers experience vicarious experiences of success which have been shown to increase efficacy (Guskey, 1986).

The teachers in the study did not have sufficient mathematics specific resources to use on the tablet PCs assigned to the students. Although they attempted to find and create new resources, they lacked the confidence in their ability to create meaningful academic experiences for students. This lack of resources decreased confidence in the teachers' ability to utilize the technology tools and negatively impacted the efficacy they felt toward the implementation (Hegedus & Kaput, 2004; Stevens et al., 2009). Administrators could assist teachers by ensuring teachers have the time necessary to find appropriate resources and lesson plans using these new resources. This would ensure teachers had the resources aligned with the content and the confidence with which to use them. District-level curriculum coordinators could ensure technology specific resources were purchased and placed in curriculum materials. Teachers would then be able to spend time increasing knowledge of materials and instructional practice rather than searching for materials.

PLCs were utilized by teachers in the study to plan and share experiences of success with using technology in the classroom. Collaboration time was important for teachers to share mastery experiences which had been shown to increase self-efficacy (Guskey, 1986). Administrators in the case study school provided time and resources for teachers to engage in PLC discussions, which positively impacted their ability to learn vicariously from each other. Schools considering similar initiatives should assure teacher teams have collaboration time monitored by administrators to guide positive discussions and share vicarious experiences to build efficacy.

Recommendations for Future Research

The purpose of the present study was to build upon prior research on self-efficacy of teachers to learn how teaching with technology tools, specifically 1:1 computing devices, impacts teaching and learning. This study expanded the research by focusing on a subset of teachers and analyzing self-efficacy within a particular context, technology tools, which had limited scope of research. There are areas of future research that could be expanded from the present study.

First, how does the collective efficacy of teachers within a school building impact the teaching of students with technology tools? This study analyzed the self-efficacy of teachers and their personal views of utilizing technology tools for instruction in Algebra 1. With the increased use of PLCs in planning for instruction, this may impact the collective efficacy of teachers in how they work together to implement technology practices in instruction. PLCs can be used effectively to build collective efficacy (Bandura, 1997), and may assist in the overall implementation of technology practices in schools. This research could be completed by analyzing the PLC structure of a school utilizing technology tools and how the PLC focuses on the technology integration for meaningful instructional practice.

Second, what impact does professional development on the specific technology integration within a content area have on technology integration? The teachers in the present study were concerned the training provided to them for the integration of technology tools was too generic and not specifically applicable to their classroom and subject area. Providing subject-specific training in Algebra 1 usage of computers should positively impact implementation (Paraskeva et al., 2008). Further research could analyze types of technology professional development programs to understand if training on the use of the technology tool itself leads to meaningful integration. Specific training on the use of technology tools for a content area could be analyzed, along with job embedded professional development, to understand how those practices impact instruction.

Conclusion

The purpose of this study was to analyze the interaction of self-efficacy and technology integration in Algebra 1 classroom. Through a case study approach, findings were shared relating how self-efficacy impacted the integration of technology for meaningful mathematical instruction. Teachers in the study reported low self-efficacy towards using technology for mathematics instruction due to the lack of subject specific professional development and a lack of resources targeted towards Algebra 1 instruction. Self-efficacy was increased through the use of PLC discussions focused on vicarious experiences of success. Administrators at the school were instrumental in making sure technology tools were utilized, and in ensuring the teachers were able to set aside time for PLC discussions. Further research should focus on the collective efficacy benefits from PLC and a coaching model integrating mathematics specialists into the classroom for ongoing professional development.

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