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Effective Technology Strategies Teachers Use in the Urban Middle Grades Mathematics Classroom

Tammie R. Cravens
Georgia State University

ACCEPTANCE

This dissertation, EFFECTIVE TECHNOLOGY STRATEGIES TEACHERS USE IN THE URBAN MIDDLE GRADES MATHEMATICS CLASSROOM, by TAMMIE R. CRAVENS, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

Christine D. Thomas, Ph.D.
Committee Chair

Pier A. Junor Clarke, Ph.D.
Committee Member

Wanjira Kinuthia, Ph.D.
Committee Member

Desha L. Williams, Ph.D.
Committee Member

Date

Dana L. Fox, Ph.D.
Chair, Department of Middle-Secondary Education and Instructional Technology

R. W. Kamphaus, Ph.D.
Dean and Distinguished Research Professor
College of Education

AUTHOR'S STATEMENT

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Tammie R. Cravens
P. O. Box 310197
Atlanta, GA 31131

The director of this dissertation is:

Dr. Christine D. Thomas
Department of Middle-Secondary Education and Instructional Technology
College of Education
Georgia State University
Atlanta, GA 30303-3083

VITAE

Tammie R. Cravens

ADDRESS: P. O. Box 310197
Atlanta, Georgia 31131

EDUCATION:

Ph.D.	2011	Georgia State University Teaching and Learning
NBCT	2003	National Board of Professional Teaching Standards Early Adolescent Mathematics
	1995	Georgia State University Administration Add-On Certification
M.A.	1993	Georgia State University Middle Grades Education
B.A.	1983	Clark-Atlanta University Middle Grades Education

PROFESSIONAL EXPERIENCE:

2010-Present	Instructional Coach-Math/Science Young Middle School, Atlanta Public Schools
2009-2010	Gifted and Talented Endorsement Instructor Atlanta Public Schools, Atlanta, GA
2002-2006	Pre-Service Mentor Teacher Young Middle School, Atlanta Public Schools
1997-2001	After School Program Coordinator Young Middle School, Atlanta, GA
1994-Present	Mathematics Teacher Young Middle School, Atlanta, Public Schools
1983-1994	Financial Analyst Wachovia Corporation

PROFESSIONAL SOCIETIES AND ORGANIZATIONS:

2011-present	Pi Lambda Theta International Honor Society and Professional Association in Education
1993-present	Georgia Council of Teachers of Mathematics

PRESENTATIONS:

2011	Response to Intervention In-service Workshop, Young Middle School
2009-present	The New Mathematics Curriculum Annual Family Math Night Young Middle School, Atlanta, GA
2008	Multiple Representations in Mathematics In-service Workshop, Young Middle School
2006	Using Data In-service Workshop, Atlanta Public Schools
2005	Math is Out of Site! GSCA Peer Helper's Conference, Milledgeville, GA
2003	Touched by an Angle South Carolina Regional Conference National Council of Teachers of Mathematics

ABSTRACT

EFFECTIVE TECHNOLOGY STRATEGIES TEACHERS USE
IN THE URBAN MIDDLE GRADES
MATHEMATICS CLASSROOM
by
Tammie R. Cravens

The 21st century mathematics classroom looks and operates differently than it did half a century ago. Not only are teachers expected to facilitate activities rather than lecture, they are also expected to utilize technology. The National Council of Teachers of Mathematics established the technology principle to guide teachers into this practice in 2000. Today there are middle school mathematics teachers who use technology effectively in the classroom. However, there is a dearth of literature in this area on how they select and use technology. The purpose of this qualitative study is to understand the process by which these teachers select and use technology in their classroom. Activity theory and teacher thinking process model provided a conceptual framework for this study. The guiding research questions are: (1) How do successful urban middle grades mathematics teachers, who use technology effectively, describe their teaching practices? (2) What are the strategies teachers use when integrating technology effectively in the classroom?

Using a case study approach, the researcher collected data over 4 months from 3 urban middle school teachers – one on each grade level 6th, 7th, and 8th. Data sources included lesson plans, semi-structured interviews, and classroom observations. Findings revealed that teachers consider the types of learners when deciding what technology is appropriate to use. Teachers also preview technology prior to using it in the classroom. Emerging themes were grouped in five categories to describe how teachers plan and

implement technology effectively. They are preparation, engagement, assessment, communication, and evaluation. The research findings give strategies to support teacher's decisions about using technology for all types of learners and how to be effective in every phase of learning – whether it is introducing a lesson, remediating skills, or assessing knowledge. These findings also enable stakeholders to make informed decisions about technology in their school so that teachers will be able to elevate the quality of instruction with appropriate technology resources. Extended research should measure the impact that technology has on student learning. The likelihood of teachers using technology and using it more often would increase at a faster rate if there is evidence that the growth of student achievement occurs more rapidly when using technology.

EFFECTIVE TECHNOLOGY STRATEGIES TEACHERS USE IN THE URBAN MIDDLE GRADES MATHEMATICS CLASSROOM

by

Tammie R. Cravens

A Dissertation

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My love to you all!

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACOT	Apple Classroom of Tomorrow
ALN	Asynchronous Learning Networks
CHAT	Cultural-Historical Activity Theory
GOMS	Goals, Operators, Methods, and Selection (model used to analyze human-computer interactions)
IRB	Institutional Review Board
ISTE	International Society for Technology in Education
LCD	Liquid Crystal Display
NAEP	National Assessment of Educational Progress
NCES	National Center for Education Statistics
NCLB	No Child Left Behind Educational Act of 2001
NCREL	North Central Regional Education Laboratories
NCTM	National Council of Teachers of Mathematics
NETS	National Educational Technology Standards
OTA	Office of Technology Assessment
USDOE	United States Department of Education
VEC	Virtual Education Community

Chapter One

Introduction

> The effective use of technology in the mathematics classroom depends on the teacher. Technology is not a panacea. As with any teaching tool, it can be used well or poorly. Teachers should use technology to enhance their students' learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently and well – graphing, visualizing, and computing (National Council of Teachers of Mathematics, 2000, pp. 25-26).

The 21st century classroom looks and operates differently than it did half a century ago. Not only are teachers expected to facilitate activities rather than lecture, they are also expected to utilize some form of technology that promotes mathematical thinking and strengthens the likelihood of skill mastery. Why is the implementation of technology the expectation in today's classroom? Why aren't the old methods just as effective? It is because we are immersed in a completely new era, termed by Thomas Friedman as Globalization 3.0 (Friedman, 2007). Our world has transformed from an Industrial Age to an Information Age to a Global Society, and the ability to use technological tools determines to a large degree how successful a person will be in a global economy. This new era is shrinking the world from a size small to a size tiny and flattening the playing field at the same time – empowering individuals to collaborate and compete globally (Friedman, 2007). Teachers' willingness, comfort, and ability to utilize and integrate technology into classrooms are keys to providing a rigorous classroom experience (Leu, 2000) and bridge learning beyond four walls into the real-world.

The role of technology in today's classroom is explained in five ways according to Bransford, Brown, and Cocking (2000). Technology is able to bring real-world experiences into the classroom. It provides scaffolding that allows learners to participate in complex cognitive tasks and increases opportunities to receive sophisticated and individualized feedback. Technology also builds communities of interaction between teachers, students, parents, and other interested groups, and expands opportunities for teacher development. According to the National Center for Education Statistics (2002), technology literacy is defined as computer skills and the ability to use computers and other technology to improve productivity and performance. This technology literacy should be employed by teachers on varying levels in their instructional setting to prepare students to meet the requirements of today's job market, which is now more competitive than ever, and involves a hi-tech work environment.

The purpose of this research is to investigate effective use of technology by successful teachers in urban middle schools as a tool for advancing mathematics achievement in the classroom. The teachers selected for this study not only know how to use technology, but they know what technology is appropriate to use with students to support their learning. "Technology involves the tools with which we deliver content and implement practices in better ways; . . . Integration is defined not by the amount or type of technology used, but by how and why it is used" (Earle, 2002, p. 11).

Using technology effectively is important in this study because the goal is to report to the audience those characteristics and practices successful teachers employ that make using the technology effective. Although teachers may be technology literate in varying degrees, it matters not how much they know, but how well they use what they know to engage students and advance student learning that matters most. It is not just merely having technology in the classroom and available whenever students want to use it. Neither is it meant to use as a substitute for teaching to keep students occupied while teachers work on other tasks. There are varying uses of technology to help teachers in the classroom. Teachers either use technology as a communication tool or as an instructional tool. For example, teachers use e-mail to exchange information among colleagues, parents, and students, and also to develop lesson plans. These are ways teachers use technology as a means of communication. Examples of using technology as an instructional tool are utilizing software programs to promote understanding of mathematical concepts by posing real-world problems, creating graphics to model mathematical situations, or using illustrations and interactive software programs to remediate skills.

This study focuses on how successful teachers effectively use technology with instruction, and examine their actual classroom practices with technology with respect to student learning. In order to approach this study in a manner that eliminates misinterpretation of terms used, it is important to first justify why this study focuses on urban classroom settings, and then define the terms ‘successful teacher’, ‘technology’, and ‘effective use’.

Urban schools are defined as schools located within a large metropolitan area and serving socially and academically at-risk children (Ballou, 1996). Urban schools serve a large population of minority and poor students who are at risk of failing in school (Wang, Haertel & Walberg, 1998). Moreover, urban classrooms are often characterized by "disciplinary problems, large class sizes, lack of time for individual interaction, busing policies, and lack of student participation in extracurricular activities" (Lomotey & Swanson, 1989). This study focuses on the urban classroom because despite these characteristics teachers are engaging students and advancing student achievement with their effective use of technology. In addition, acquiring technology is often more challenging for rural schools than it is for their urban counterparts (Katsinas & Moeck, 2002, Silvis, 2000) and rural households are less likely to have computers and internet service than are urban households (U. S. Department of Commerce, Economics and Statistics Administration and National Telecommunication and Information Administration, 2000). Since home access is considered important, research indicates that students who use computers at home generally come to school already comfortable with computers and do not need to learn basic skills before they can begin reaping the benefits of information technology in education (Lauman, 2000). Therefore, a wealth of resources, accessibility, and student knowledge in the urban schools provides a more appropriate setting for this research.

Primarily, teachers whose students consistently perform well on formative and summative assessments in mathematics are considered successful teachers. However, other tenets of successful teaching are also rooted in the frameworks of Ladson-Billings (1995) and Gehrke (2005). Ladson-Billings (1995) identified the successful teacher as one who uses culturally relevant pedagogy, which consists of demanding academic excellence of students, helping students develop and maintain cultural competence, and helping students to develop a critical consciousness through which they challenge the status quo of the current social order. Successful teachers studied by Ladson-Billings (1995) were committed to teaching with a standard of excellence and attempted to create a bond with their students. Those teachers were not dependent on state curriculum frameworks or textbooks to decide what and how to teach. They created alternate strategies using explorative methods to meet mandated standards. The teachers exhibited a passion and vitality about what they taught. They worked to help students with skill deficiencies build bridges or scaffolding so they could be proficient in the more challenging work they experienced in the classroom.

Gehrke's philosophy of successful teachers in urban schools is embedded in three primary characteristics: knowing themselves, knowing the environment in which they teach, and maintaining high expectations (Weiner, 1993; Guyton, 1994; Brophy, 1999 as cited in Gehrke, 2005). Successful teachers of urban students are aware of their own personal beliefs and philosophies and how their background may be different from those they teach. They are able to select strategies, methods, and materials that engage their learners, enable students to relate learning to their lives, and subsequently lead to increased achievement. Secondly, successful teachers in urban schools have a strong knowledge base about teaching in schools in urban areas and the lack of resources and services that form the basis for current legislation designed to remedy inequities in educational opportunities. Lastly, clear expectations are the result of an underlying pedagogy where successful teachers believe that all children can learn and that the environment is not an excuse to lower expectations. These teachers also are able to communicate that belief to their students. In today's standards-based accountability environment, where schools are categorized as effective based on annual standardized test scores, it is even more critical that teachers in urban settings adhere to this premise (Gehrke, 2005). From this perspective, the successful teacher is defined in this study as those teachers who have high expectations of their students and use the curriculum standards as a guide to select appropriate methods, strategies, and materials to engage all students in meaningful activities that lead to student achievement.

When the word 'technology' is mentioned in this day and time, computer hardware and software applications usually come to mind. Historically, technology has been used to refer to anything requiring batteries or electricity. This includes the old adding machines, tape recorders, film strip projectors, and televisions; but it also includes today's electronic devices such as DVD players, iPods, PSPs, PDAs, graphing calculators, and computers. For the purpose of this study, however, technology is defined as those applications accessed through the use of computers (laptops or desktops), Promethean Boards or Smartboards, and handheld devices, such as calculators and iPods. This does not include the use of overhead projectors because they are typically used as a visual aid tool for note taking in lieu of writing on a chalkboard, and the equipment does not require any student interactivity leading to student mastery of mathematical skills.

Teachers who use technology as an instructional tool have acquired the necessary training to operate it effectively, and expect a positive learning outcome from students. Research from the 1995 Apple Classroom of Tomorrow (ACOT) project produced a model showing the stages of development teachers go through for using technology in the classroom. These five stages are:

- Entry – Learn the basics of using technology
- Adoption – Use new technology to support traditional instruction
- Adaption – Integrate new technology into traditional classroom practice
- Appropriation – Focus on cooperative, project-based, and interdisciplinary work, incorporating the technology as needed and as one of many tools
- Invention – Discover new uses for technology tools (Apple Computer, Inc., 1995).

These Stages of Instructional Evolution are representative of the level of technology literacy a teacher possesses to be effective in the classroom. The more technology is used and viewed as effective the more likely the teacher will increase its use to disperse throughout the curriculum, to broaden students' experiences and advance their understanding. The effective use of technology, however, is not dependent solely on the technology. The teacher must also be knowledgeable of the curriculum standards and demonstrate an acceptable level of competence in the content area, as well as know the appropriate methods and pedagogical strategies to implement. All combined, this is known as technological pedagogical content knowledge, or TPACK (Koehler & Mishra 2009).

> TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technology; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help

redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler & Mishra 2009, pp. 66).

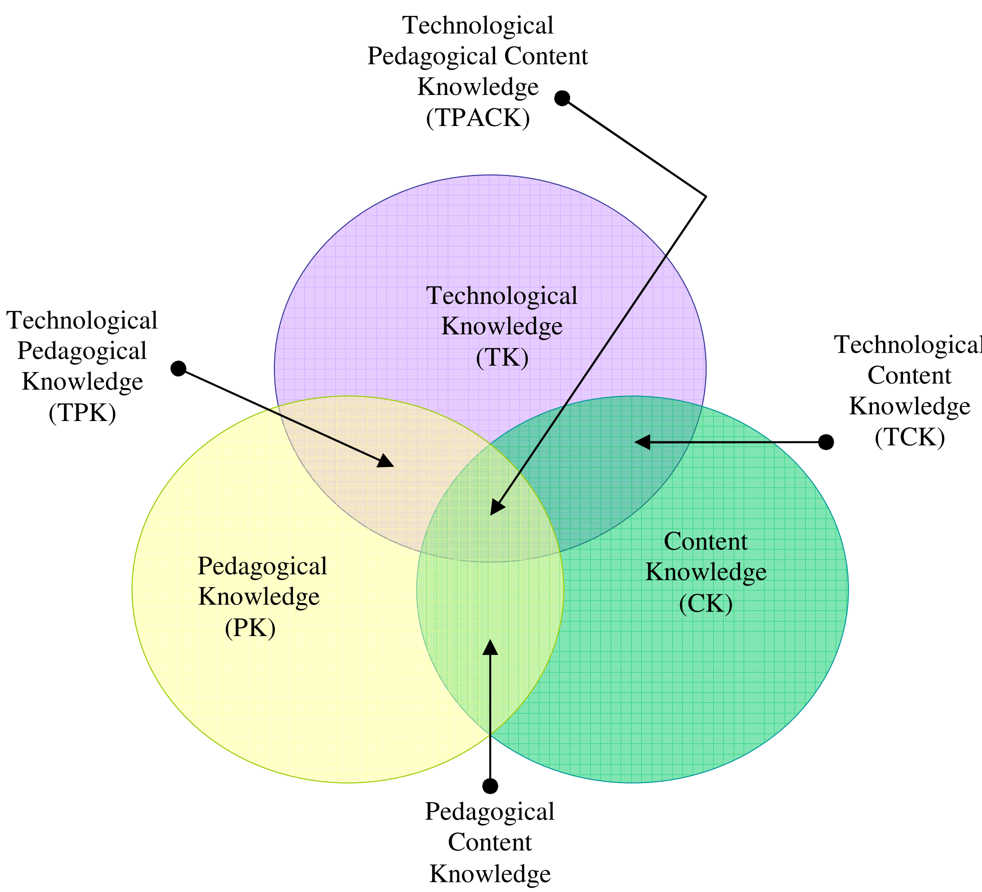


Figure 1. The TPACK framework and its knowledge components. Adapted from "What is Technological Pedagogical Content Knowledge? by M. J. Koehler and T. Mishra, 2009, *Contemporary Issues in Technology and Teacher Education*, 9(1), p. 63.

In the model shown (Figure 1) teachers use three main bodies of knowledge (content, pedagogy, and technology). Although each has its own significance, the overlapping of them increases the variety and quality of instruction for teachers and students. At the center of the model is where these successful teachers operate. In this study a teacher who 'uses technology effectively' is defined as one who is able to combine their content knowledge, pedagogical knowledge, and technological knowledge (TPACK) to facilitate classroom activities, using technology as a tool to support learning where students are able to understand, analyze, and synthesize information by constructing representations of their own knowledge.

Problem Statement

There are middle school mathematics teachers who are successfully using technology in the classroom. However, there is a dearth of literature in this area that describes how they select and use technology. Many of the mathematics classrooms today have not shifted into the 21st century to meet the demand for technology usage with instruction. Therefore, much of the research has focused on the lack of technology in the classroom, the impact of technology in the classroom, or the barriers to using technology. According to Hativa and Lesgold (1996), there is substantial survey evidence that, almost three decades after the computer was first introduced in schools, it has not brought about a widespread revolution in methods of teaching or in school structure and organization.

Those who are using technology effectively should be exposed so that teachers who are not using technology will learn the appropriate strategies and hopefully begin implementing them in their classroom. As technology innovation emerged to enhance the quality of instruction, teachers were provided with more resources that would enable students to visualize mathematics and make real-world connections. One of the major forces driving change has been the assumption that meanings are lost if learning is simply the transmission of information. Technology is a determining factor of the learning environment because of the influences it exerts on cognitive, motivational, and social aspects of the activity performed by the user with this technology (Bottino & Chiappini, 2002). In fact, the International Society for Technology in Education (ISTE, 2008) defined successful schools as those that provide integrated technology experiences for their students to:

- Increase their technology capabilities
- Seek, analyze and evaluate new information
- Become problem-solvers and decision-makers
- Use tools creatively and effectively to assist them in decisions
- Become communicators, collaborators, publishers and producers.

According to the National Council of Teachers of Mathematics (NCTM, 2000), technology is an essential tool for teaching and learning mathematics effectively. As one of NCTM's six principles for high quality mathematics, technology extends the mathematics effectively taught, and enhances student learning. It should be used as a tool to model, graphically represent, and analyze data as an aid in building new knowledge so students will generalize, recognize connections, and represent ideas and thoughts differently (NCTM, 2000). Technology offers teachers options for adapting instruction to special student needs. Students who are easily distracted may focus more intently on computer tasks, and those who have organizational difficulties may benefit from the constraints imposed by a computer environment. Students who have trouble with basic procedures can develop and demonstrate other mathematical understandings, which in turn can eventually help them learn the procedures (NCTM, 2000).

Students from different mathematics background and those who have done poorly on mathematics concepts can benefit from multimedia technology because it has the capability of demonstrating higher order mathematics concepts (Landesman, 1999). Bellamy (1996) reveals how technologies must be designed to support not only students' learning activities but also teachers' activities, because it is only by understanding and designing for the whole education situation that effective and valuable changes can be brought about in the classroom.

Because technology and society are always in a state of change, successful teachers find and use a variety of resources to help them present interesting and relevant information to students (Reeve, 2006). Technological advances afford teachers many opportunities to appropriately apply, and implement new technological learning experiences within their classroom. However, these opportunities are not being seized in many mathematics classrooms due to teacher apprehension about using technological tools that foster innovative, inquiry-based approaches to learning (Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000; Mariotti, 2002). In order to achieve the level of expectancy from society, NCTM and district curriculum guides, teachers should develop innovative practices and use technology flexibly and purposefully to assist students in successful mathematical thinking processes; visualization, communication, and representational skills; mathematical understandings and self-awareness; and problem solving. This study will report the findings of those teachers who consistently (at least 3 lessons per week) incorporate these practices and receive positive results.

Research Question

This study explores the following questions to guide the data collection process. How do successful urban middle grades mathematics teachers who use technology effectively, describe their teaching practices? What strategies do teachers use when integrating technology effectively in the classroom? In order to answer these questions the researcher will explore the conditions and practices that influence effectiveness, and the relationship between what teachers say about their use of technology and their actual practices in the classroom.

Rationale

Prior research has focused on the implementation, exploration, and learner outcomes of various technologies used in the classroom, and on professional development training models used to prepare teachers for technology integration. However, this study is unique in that its focus is not on the technology, but on the teacher's process of when and how to select and use appropriate technology, and their effective classroom practices with technology. Realizing that educational technology and its use is changing and expanding so rapidly, I am excited with learning about the diverse resources available, and knowing what is appropriate to use and when. I feel students are at a disadvantage when I visit other schools and see technology not being used, whether it is due to a lack of funding for equipment and teacher training, non functioning equipment, or obsolete equipment. Knowing that NCTM encourages and supports the use of technology in the classroom, and given the increasing demand from the labor market for employees to have some degree of technology literacy, teachers should be more willing to embrace the use of technology as a support of today's teaching methods. In order to ensure that students will adequately meet the demands of the global market, teachers should use more technology research-based strategies in the classroom.

The table listed below (see Table 1) shows statistical data retrieved from the Education Counts database, which collects data for annual reports published in the Education Week, Quality Counts and Technology Counts Magazines (EdCounts, 2009). School administrators, teachers, and students throughout the United States participated in a survey about the technology used during classroom instruction. Although the data shows inconsistent growth over the years in teachers' use of computers for planning and teaching (Table 1), there is a steady increase in their use of the Internet for instruction (Table 2). The data in Table 3 specifically identifies mathematics teachers of 8^{th} grade students who use the computers for math instruction. Data was collected by asking teachers, "If you do use computers, what is the primary use of these computers for mathematics instruction?" The phrasing of the question lends itself to the obvious, that teachers choose the kind of technology to use, and when to use it in their classroom, which supports the question at the base of this study. Their response revealed that the majority of computer time is used for drill and practice, followed by math games, and then least of all simulations and applications. Upon noticing that this number is extremely low, the reader may want to know how many of the teachers surveyed in Table 2 are mathematics teachers.

Statistical Data on Technology Usage in the Classroom by Teachers

Table 1

Computer Usage

Southeastern States	2000 Percent of teachers using computers for planning and/or teaching	2001 Percent of teachers using computers for planning and/or teaching	2002 Percent of teachers using computers for planning and/or teaching
Alabama	69	78	83
Florida	80	84	79
Georgia	84	89	89
Mississippi	64	74	78
South Carolina	81	82	79
Tennessee	80	73	82
U. S. Average	76	78	83

Note. Adapted from Editorial Projects in Education Research Center (2009, November 7). Retrieved from http://www.edweek.org/rc/2007/06/07/edcounts.html

Table 2

Internet Usage

Southeastern States	2000 Percent of teachers using the Internet for Instruction	2001 Percent of teachers using the Internet for Instruction	2002 Percent of teachers using the Internet for Instruction
Alabama	58	63	74
Florida	47	57	63
Georgia	53	66	72
Mississippi	65	65	78
South Carolina	70	75	81
Tennessee	71	71	73
U. S. Average	63	69	73

Note. Adapted from Editorial Projects in Education Research Center (2009, November 7). Retrieved from http://www.edweek.org/rc/2007/06/07/edcounts.html

Table 3

Computer Usage for Math Practice with Eighth Graders

Southeastern States	2000 Percent of 8th graders whose teachers use computers for drill and practice during math instruction	2000 Percent of 8th graders whose teachers use computers to play math games for math instruction	2000 Percent of 8th graders whose teachers use computers for simulations and applications for math instruction
Alabama	28	13	7
Florida	-	-	-
Georgia	29	11	14
Mississippi	16	12	3
South Carolina	33	12	12
Tennessee	20	22	8
U. S. Average	16	13	12

Note. Adapted from Editorial Projects in Education Research Center (2009, November 7). Retrieved from http://www.edweek.org/rc/2007/06/07/edcounts.html

As students and teachers become more adept at capitalizing in technological opportunities, the more they need to understand, reflect on, and critically analyze their actions; and the more researchers need to address the impact of these technologies on students' and teachers' mathematical development (Niss, 1999). We need to be more innovative in the ways we use technology in the teaching of mathematics. As Roschelle, Kaput, & Stroup (2000) emphasized, routine applications of technology will not meet the order of magnitude of challenges we face in bringing much more mathematics learning to many more students of diverse backgrounds. More research needs to be done on technological advances in mathematics education, including the design and implementation of appropriate learning experiences and how they impact the development of both students and teachers (English, 2002). This study is designed to provide research-based evidence of effective strategies utilizing technology in the urban middle school mathematics classroom.

Significance

A study of how teachers effectively use technology in the mathematics classroom is important for several reasons. Primarily, the study is designed to provide a deeper understanding of when and how to use technology with students in a middle grades mathematics classroom and the benefits it provides. Secondly, it focuses on the teacher rather than the technology, which will provide insights to educators and coordinators of professional development to make effective decisions about evaluative procedures and teacher training. Saliently, this study may provide encouragement and motivation to the reluctant teacher on progressive measures to practice utilizing technology and provide new insights on what teachers think they do and what actually takes place in the classroom.

Theoretical Framework

The theoretical framework chosen for this study is based on Activity Theory and Teachers' Thought Process Theory. Activity theory has its threefold historical origins in classical German philosophy, in the writings of Marx and Engels, and in the Soviet Russian cultural-historical psychology of Vygotsky, Leont 'ev and Luria. Aleksey Leont'ev, a disciple of Vygotsky, founded activity theory while studying under the direct supervision of Vygotsky. Many ideas underlying cultural-historical psychology were assimilated into activity theory, and because the line between the two is so fine, these two approaches are referred to as cultural-historical activity theory (CHAT). Activity theory was introduced to an international audience in the late 1970s and early 1980s. Today activity theory is transcending its own origins: It is becoming truly international and multidisciplinary. This process entails the discovery of new and old related approaches from American pragmatism to theories of self-organizing systems (Engestrom, 1999). Activity theory seeks to understand the unity of consciousness and activity. It is a social theory of human consciousness, construing consciousness as the product of an individual's interactions with people and artifacts in the context of everyday practical activity (Kaptelinin & Nardi, 2006). Kuutti (1996) defines activity theory as a framework that enables the study of different forms of human praxis as developmental processes, both individual and social levels interlinked at the same time, viewing it as a framework that focuses on the interaction of human activity and consciousness within its relevant environment context. Hence, it enables the researcher to analyze the context within which the activity is taking place and to report on the interactions (Divaharan, 2002).

Activity Theory operates as a philosophical and cross-disciplinary theory for studying different forms of human practice, such as teaching-learning practice, as development processes mediated by artifacts, in which individual and social levels are interlinked at the same time (Kuutti, 1996). In activity theory the cultural role of the teacher is emphasized and it offers a system of tools to relate the global level of activity developed over time to the individual operations realized by the teacher on the spot. It focuses on the activities which community members engage, the goals of those activities, the physical setting that constrains and affords certain actions, and the tools that mediate activity.

Bellamy (1996), asserts that activity theory is an appropriate framework for analysis of technological innovation because it is part of a general process of cultural evolution in which artifacts mediate human activity, and that all of the inter-relationships in the systematic model (Figure 2) should be taken into consideration in the design process. Activity theory recognizes two basic processes operating continuously at every level of human activities: internalization and externalization. Internalization is related to reproduction of culture; externalization as creation of new artifacts makes possible its transformation. These two processes are inseparably intertwined (Engestrom, 1999).

Activity theory provides an effective lens for analyzing tasks and settings and provides a framework for designing constructivist learning environments (Jonassen & Rohrer-Murphy, 1999). Cole and Engestrom (1993) developed a model to formulate the complex relationships between elements in an activity and is particularly appropriate to study the relationships that take place in the teaching-learning activity (see Figure 2). Their systematic model highlights three mutual relationships involved in every activity, which are the relationship between subject and community, subject and object, and community and object. Each of these relationships is mediated by the tools, rules, and the different roles characterized by the labor organization.

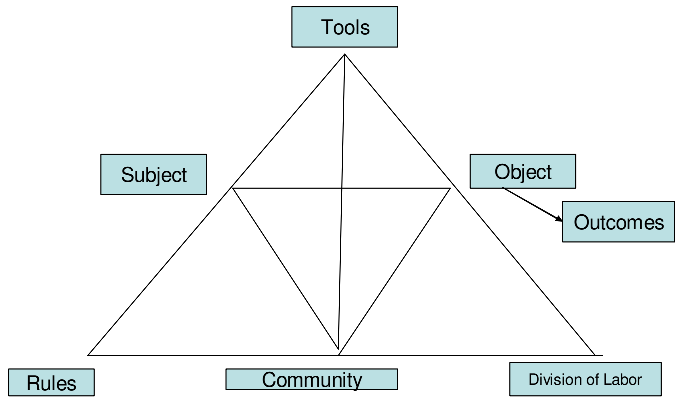


Figure 2. Activity Theory Model adapted from Perspectives on Activity Theory, by Y. Engestrom, R. Miettinen, and R. Punamaki, p. 31, Copyright, 2009, Cambridge University Press, New York

The activity model (Figure 2) consists of subject, object, tools (or artifacts), rules, community and division of labor. The subject of any activity is the person or group of people under study, which in this particular study, the teachers are the main focus; therefore, they are the subjects of the activity model. The object of the activity model is the eventual product that the activity hopes to achieve. In this case, effective technology strategies are the end products. Traditional analytical thinking, typical, for instance, of natural sciences, would assume that to understand an activity it is necessary to understand the subject and the object separately and then make an inference about their interaction (Kaptelinin & Nardi, 2006). Activity theory, however, proposes that an understanding cannot be achieved by focusing on the subject or object separately. Some situations may present a cause-effect relation between the subject and object operating in reverse of what is predicted or anticipated, and therefore, could not be identified if examined separately.

The tools used in this model would be the lesson plans, curriculum standards, and any form of technology used in the classroom to support student learning. Rules refer to those expectations established by the teacher while working individually or in groups during class time. Rules may also represent the process of selecting the technology tools to use in the lesson. Identifying effective strategies begins with evaluating the selection of tools chosen to advance student achievement. The community would be the classroom setting consisting of students and adults with whom the teachers must interact with to use technology. Division of labor identifies the various roles each person assumes in order to complete the activity. The activity theory model will provide clarity when analyzing the data collected in the study, assisting the researcher with understanding the interconnection between all components of the model. The utilization of activity theory, according to Nardi (1996), provides a rich framework to study human activity and the tool that mediates or alters human activity in the context within which the tool is used.

Koszalka and Wu (2004) conducted a case study using CHAT (cultural historical activity theory) to investigate technology integration and how teaching methods and technology strategies changed over time. The study compared traditional cognitive research to cultural historical activity theory to identify the role each plays in the learning process. It suggests that those who use traditional cognitive paradigms believe that learning is a permanent change in schema that occurs through assimilating and accommodating external information into schema; CHAT, on the other hand, assumes that outcomes (knowledge) are constructed by interaction within an activity among users, technology, and environmental factors all within a context (Koszalka & Wu, 2004). The results of the study noted that many changes occurred. Those changes were traced to historical and activity factors, which included development of new knowledge of strategies and resources, support mechanisms, curriculum requirements, peer collaborations, technology access, and teachers' personal perceptions, attitudes, and experiences. In addition, the researchers were convinced that using a CHAT framework yields richer data, more comprehensive results and understanding of the changes within the activity, and provide a holistic view by investigating the relationships across different analysis results. They also concluded that using a CHAT strategy helps to reveal technology integration activity's content, structure, organization and fundamental characteristics as they exist within the training and classroom context (Koszalka & Wu, 2004).

Schneiderman (2002) identified five types of roles and uses of theories (which are not mutually exclusive) (1) descriptive theories identify key concepts or variables and make basic conceptual distinctions; (2) explanatory theories reveal relationships and processes; (3) predictive theories, such as Fitts' Law or GOMS, make it possible to make predictions about performance in a range of potential contexts; (4) prescriptive theories provide guidelines based on best practice; and (5) generative theories facilitate creativity, invention, and discovery (as cited in Kaptelinin & Nardi, 2006). Activity theory can play at least three of these roles. First, it is a descriptive theory that identifies a number of fundamentally important concepts such as mediation. Second, it is an explanatory theory that suggests mechanisms explaining why and how certain phenomena take place. And, it is a generative theory, with application to problems of interaction design as well (Kaptelinin & Nardi, 2006).

Activity theory has been criticized by some philosophers and psychologists because it is alleged to be an expression of totalitarian ideology (Lektorsky, 1999). Among those who severely criticized activity theory was Christopher S. L. Rubinstein (Toulmin, 1999). Rubenstein maintained that activity as a whole cannot be the subject matter of psychology. He stressed that human activity cannot be understood as simple internalization of ready-made standards, while Leont'ev objected to that position, emphasizing that psychological research should focus on the activity as a whole in order to understand the interdependent components of the activity (Kaptelinin & Nardi, 2006).

Some of Leont'ev's colleagues within the Moscow School of Psychology developed their own approaches, which were somewhat similar to activity theory, but differed in a number of ways. Galperin developed a theory of stage-by-stage formation of psychological functions, which deals with mechanisms and conditions of internalization.

Davydov (1999) identified several problems with activity theory, and therefore, developed a theory of essential generalization, which is a mixture of Vygotskian concepts, Ilyenkov's dialectical logics, and activity theory. This approach supports the idea that education should aim at creating optimal conditions for conceptual transformations referred to as essential generalizations, which requires the student to reach an understanding that reveals the underlying principle of a concept and apply the principle to specific instances of the concept. One of the problems he found with activity theory was the transformation that is said to take place. Transformation is thought of as a process by which an object changes. However, Davydov argues that every change is not necessarily a transformation because it is possible to change externally without changing internally. Transformation means changing an object internally, making evident its essence and altering it (Davydov, 1999). Another problem Davydov found with activity theory is the various meanings attached to the term activity. Activity is a broad term that is too inclusive of different types. Activity in one arena may refer to learning or playing, while in another setting may refer to scientific, political, or psychic process. Different disciplines classify different types of activity, whose meaning may vary, and should be defined. In this study, activity refers to the use of technology applied in a learning environment.

In summary, the educational system in the United States is transforming its teaching practices to include technology in order to prepare students to compete locally, nationally, and globally; but first it must also prepare its teachers, who may be reluctant, transitioning, or fully enveloped in today's world of technology, to be competent and accountable for these students. Knowing that technology is regularly mainstreamed in today's classrooms, research continues to explore what is functioning well, and what issues need to be addressed. This research is examining an aspect of technology that is functioning well. This is a study about teachers who know how to utilize technology effectively in the classroom. In this study the audience will learn about teacher practices that make using technology effective.

Teachers' Thought Processes

Effective teaching often begins with thinking, planning, and making decisions about what to teach, how to teach it, and when and how to evaluate its effectiveness. What to teach is usually established, in most cases, by the curriculum standards adopted by the school district. However, teachers spend a lot of time thinking and deciding on ways to deliver instruction. Clark and Peterson (1986) developed a model to represent teacher thought and action in order to understand how they relate to one another in the overall process of teacher effectiveness.

Teachers' Thought Processes Model

Constraints &

Opportunities

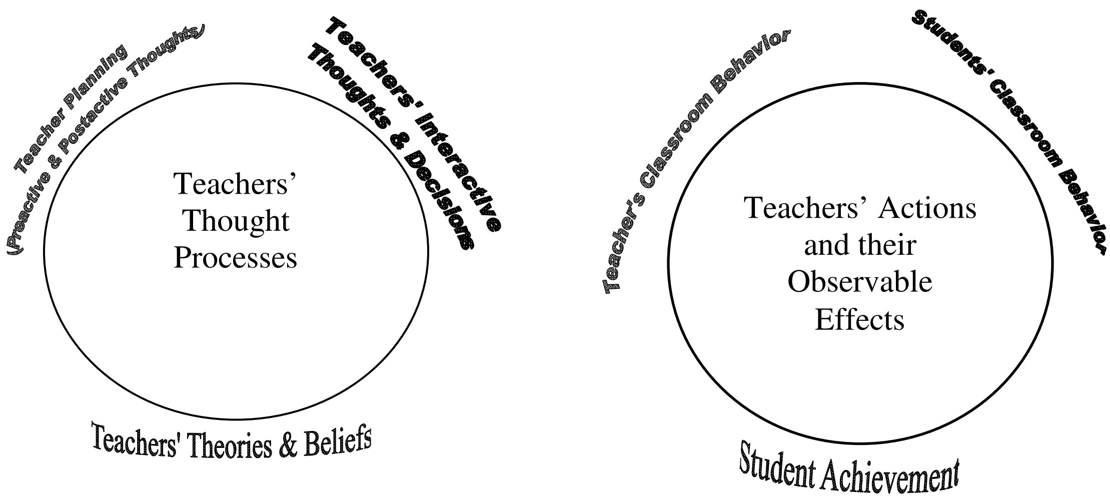


Figure 3. Clark and Peterson's Model of Teacher Thought and Action. Adapted from Teachers' Thought Processes by C. Clark and P. Peterson in the *Handbook of Research on Teaching*, p. 257, Copyright 1986, by the American Educational Research Association, Simon & Schuster Macmillan, New York.

The diagram in Figure 3 represents the two major components of teacher thought processes. The circle on the left reveals the thought process teachers experience when planning to teach a lesson. This contains the inside approach, meaning the unobservable dimension teachers involve themselves when planning. The circle on the right represents the observable dimension of teaching. These are the thoughts put into action and the outcome of those actions. This model is particularly significant to this study because it focuses largely on the left circle, as it captures the elements of the planning stage the participants will experience when deciding on which technology activities to use with their lesson. Within the thought process are three categories occurring at different phases of a lesson - the teacher planning – preactive and postactive thoughts, teachers' interactive thoughts and decisions, and teachers' theories and beliefs. The first two categories may occur before, during, or after a classroom lesson or activity. The third category, teachers' theories and beliefs, represents the rich store of knowledge that teachers have that affects their planning and their interactive thoughts and decisions (Clark & Peterson, 1986).

Constraints and opportunities are a part of the teacher thought process due to the nature of their school climate. Teachers may operate under certain constraints dictated by district personnel, or by their physical environment. Consequently, teachers may have more flexibility to make decisions about their classroom activities. "The extent to which responsibility and participation in the decision making process is given to teachers (here defined as constraints and opportunities) has been shown to be an important variable that defines effective schools. Therefore, we deem this variable an important one that needs to be included in any model of the process of teaching "(Clark & Peterson, 1986, p. 258).

To better understand how the participants of this study select their technology activities, it is helpful to know the various types of teacher planning derived from the findings of eight studies conducted in the late 70s and early 80s. First, the definition of teacher planning as defined by Clark and Peterson is as follows:

> Researchers have thought of planning as a set of basic psychological processes in which a person visualizes the future, inventories means and ends, and constructs a framework to guide his or her future action. This conception of planning draws heavily on the theories and methods of cognitive psychology. Researchers have also defined planning as "the things that teachers do when they say that they are planning", which suggests a phenomenological or descriptive approach to research on teacher planning, in which the teacher takes on an important role as informant or even as research collaborator (p. 260).

Yinger (1977) and Clark and Yinger (1979) determined that there are eight basic types of planning utilized by experienced teachers. They are weekly, daily, unit, long range, lesson, short range, yearly, and term planning. Cited in their studies as the most important types of planning were unit planning, weekly planning, and daily planning. Yinger (1977) further discovered that planning produces routines, which are a set of established procedures for both teacher and students that function to control and coordinate specific sequences of behavior. These routines are classified as instructional routines, management routines, activity routines, and executive planning routines. These routines "played such a major role in the teacher's planning behavior that such planning could be characterized as decision making about the selection, organization, and sequencing of routines" (Clark & Yinger, 1979, p.165).

To further understand the planning process Ralph Tyler (1950) developed a linear model that described teacher planning as a sequence of four basic steps. These steps require teachers to state the objective, select the activities to support the learning objective, organize the activities, and finally, select a method of evaluation. It was years later when Yinger (1977) discovered that the planning process was not a linear process as once thought, but rather a cyclical process of three stages.

> The first stage is a discovery cycle in which the teacher's goal conceptions, knowledge and experience, notion of the planning dilemma, and the materials available for planning interact to produce an initial problem conception worthy of further exploration. The second stage is problem formulation and solution, known as the design cycle. He characterized problem solving as a design process involving progressive elaboration of plans over time. The third stage of the planning model involves implementation, evaluation, and eventual routinization of the plan (pp. 263, 265).

As a cyclical process, planning is continuous. Each stage is influenced by prior planning and teaching experiences, and interconnects to one another, operating interdependently to develop activities that have successful learner outcomes.

Chapter 2

Literature Review

In this chapter I present information to help the reader understand why it is important for teachers to use technology in the classroom. It begins with an in-depth look at current technology and the most frequently used technologies one might see in a modern day classroom. We also need to know what the literature says about the impact technology has on the classroom and what strategies have been documented already to support the effectiveness of using technology. It is also helpful to be enlightened about who these 21st century students are and how they differ today than in the previous century. Finally, this chapter concludes with understanding more about successful teachers using technology. These topics support this study to find out what strategies successful urban middle school mathematics teachers use to implement technology effectively.

Useful Technology Tools in the Classroom

The evolution of technology goes much farther back than perhaps anyone can remember. Over a half century ago teachers used film-strip, slide projectors, and two-reel projectors to enhance instruction. However, it was in the 1960s when computers were first introduced in schools. Since then the world of education changed drastically. We have seen computers reduce in size going form the huge mainframe computer to the mini computer, microcomputer, and laptop computer to what we now know as the IPad. Consequently, the usage of computers has changed from teaching about the computer to teaching with the computer. In today's classroom, teachers combine the computer, software, video, and /or laserdisc with a large-screen projection device to make polished, professional-looking, subject matter presentations to students, taking advantage of its capabilities (Finkel (1991). This chapter begins with a close-up of the technology tools used in today's classroom.

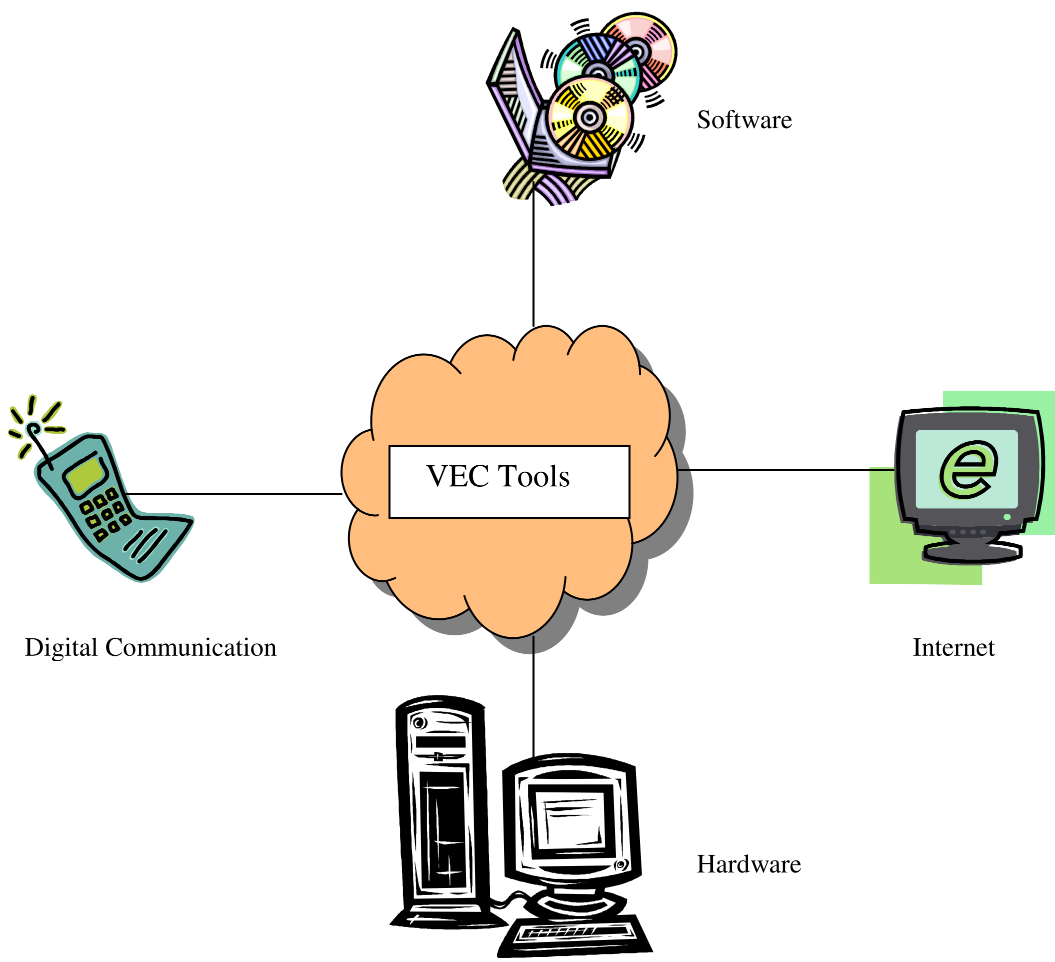


Figure 4. Virtual Education Community representing the tools teachers use to help students learn. Adapted from *6 Steps Success in Teaching with Technology* by L. Kent, 2008, Bloomington, IN, iUniverse, p. 5. Copyright 2003 by Lucas Kent.

Kent, (2008) introduces the VEC (Virtual Education Community), which includes all stakeholders - parents, teachers, students, and the community, and the tools of the VEC, namely, the hardware, software, internet, and digital communication devices that help facilitate the role of the teacher and their interaction within the VEC (see Figure 2). In today's classroom, the most frequently used hardware includes digital whiteboards, computers, cameras, PDAs, calculators, and LCD projectors. Using this hardware allows the teacher to present dynamic and meaningful lessons, and provide useful information and activities that allow instant assessment of student understanding with feedback, and the option to extend the learner's knowledge base.

The teacher should know what hardware is available in the school or district (Kent, 2008). In addition to having a portable computer for each teacher, many schools have computer labs to enable each student to access technology tools necessary to complete classroom assignments. Some schools even have portable laptop carts so that instruction could continue without interruption in the comfort of their own classroom. This provides flexibility for the teacher to differentiate instruction individually or in small groups.

Digital whiteboards have replaced the chalkboard, and is not considered a luxury, but rather a norm. They can be interactive to increase student engagement, and allow the teacher to manipulate slides with ease, saving all information presented and editing lessons as needed. Some of the accessories that can be purchased with the whiteboard are student-response systems and digital slates. The digital-response system allows the teacher to assess student understanding by creating multiple-choice questions. The students respond as each question is projected on the board using a hand-held device that is linked to the whiteboard. The teacher has instant data to use for making decisions about further instructional needs. Digital slates are used to project writing on the whiteboard without actually walking to the board. All of these tools enhance instruction for the teacher and student while making efficient use of instructional time (Kent, 2008).

Teachers use software in multiple ways. It may be videos or textbook publisher's CD-Rom software used to introduce, explain, or enhance the skills taught. It can be used as a backup storing device for important documents, and it can be used for storing and retrieving quality lesson plans, activities, and assessments (Kent, 2008).

The internet engages students and teachers by providing quick, easy access to information worldwide; and digital communication is an information tool used to connect the community to the classroom. This is especially resourceful because parents are kept abreast of their child's progress, and teachers don't have to play phone tag trying to conference with parents.

If teachers are to be effective, Kent (2008) suggests that each teacher adapt technology to fit their own teaching style. For example, if a teacher assesses students frequently, an alternate form of assessment would be to use competition by playing games that allow students to show what they know; if a teacher enjoys facilitating independent projects, the internet offers enough resources for students to use; and if the teacher wants variety in the lesson, using interactive activities and videos also provide the instructional support needed. One area that should not be avoided, however, is to know the technologies that fit various types of learners (Kent, 2008). For visual learners who learn by reading or watching, websites, videos, graphics, and blogs are preferred technological activities to use. The auditory learner, who responds by listening and talking, would benefit mostly from podcasts, videos, and online discussion groups. Kinesthetic learners, who learn by touching and doing, would respond better to digital whiteboards, interactive software and video games.

The internet is one basic technology tool every teacher has access to. It is such a useful tool for classroom instruction because it provides the teacher with access to a plethora of resources to use in a variety of ways. It also exposes students to a world of information beyond what a textbook can provide. Some teachers enjoy developing a classroom website to keep the VEC informed. Some of the features of the website include a school calendar, upcoming events, homework, and special assignments. Parents and students may also have access to the teacher after normal school hours via this website, which benefits them when questions arise about homework and deadlines, or when a student is absent from school.

Skype is one of those communication technologies, which can be used in the classroom to connect to other students around the world at no cost. With a web camera installed on the computer, teachers can even videoconference or form collaborative partnerships live from their location via skype.

Since students have become obsessed with the latest craze – My Space and Facebook, blogging has also become more popular for teachers. A blog is an interactive web page where individuals can post entries, articles, links, and pictures, and ask others to join into conversations (November, 2008). With a blog, teachers are able to create content for students to think about and respond to immediately or over a long period of time or post student work for review by an authentic, world-wide audience (November, 2010). There are some concerns, however, with teachers about blogging. Some teachers feel that they have no control over the comments made in the blog site, or that published work adds pressure to other students to perform better. Ultimately, if this form of technology is going to be used, the teacher should model the expected behaviors and establish protocol for classroom use.

Podcasts are audio or video content that can be downloaded or fed to a mobile music player (MP3 player or iPod). Creating podcasts is a creative way to reach learners and tap into a technology students may already be using outside of class (November, 2008). It is a way to publish multimedia projects online to a wide audience. For example, parents could see a video or hear a recording of their child's performance in the school's band concert, or see their child's math portfolio or presentation at the annual math/science fair.

One area of instruction that has not typically used technology in the 20th century is with assessments. However, more tools are available now, providing options for teachers in lieu of paper-pencil tests. Although a form of technology, scantron machines are not considered a technology-based assessment tool because they only allow teachers to score student responses quickly, but do not give meaningful feedback on student errors. With scantron machines, teachers still create their own paper-based assessment. These electronic devices only score answers as right or wrong, and the teacher decides how and when to address misconceptions.

Clicker assessment tools are small wireless keypads with alphanumeric keypads that are linked to a computer, often called "student response systems" (Duncan, 2005).

These hand-held devices allow individuals to respond to multiple choice questions anonymously. Their responses are transmitted to the computer, which projects the answers of the entire class. A classroom teacher can use them to assess student understanding at any time during a unit. They can be used during pre-assessment to find out what students already know, as a quiz immediately after introducing new concepts, or as a formal assessment at the end of a unit to guide further instructional needs. The advantage in using this tool is that it enables the teacher to see the item analysis and identify and address misconceptions early.

Another technology tool used to assess learning is computer-based tests. These type assessments save time in grading and giving immediate feedback to students. They also save desk space by storing information in a database rather than collecting piles of paper-based tests. Some computer-based assessments provide links to on-line tutorials to support student understanding.

Today there are many different types of technology used to support instruction. While some are preferred in one content area over another, there is some form of technology that today's classroom teacher uses. In a mathematics classroom, a teacher may use computers with mathematics software such as the geometer sketchpad or geometric supposer. These tools aid the visual learner to construct and manipulate objects and explore relationships within and between these objects (Schwartz & Yerushalmy, 1987). Handheld graphing calculators are also visual tools that assist students with problem solving, manipulating, organizing and representing data. Those mentioned here are some of the most commonly used forms in the first decade of the new millennium. Who knows how these will change in the next decade, or by halfway through the 21st century.

Importance of Technology in the Classroom

The use of technology (whether accessing the Internet, using basic software tools, podcasting, or anywhere in between) is so important in this generation of learners that it impacts every area of life whether it is personal, political, social, or economic. Wickman (2009) believed that students would not be prepared for the real world and the expectations of employers unless they are given an opportunity to use technology.

Goals established by the United States Department of Education (USDOE) required all students and teachers to have access to information technology, and for teachers to effectively use technology to help students achieve high academic standards (Department of Public Education, 2000). The USDOE also stated that technologies provide students with access to a vast array of information and resources far greater than could ever be provided within the four walls of a classroom, allowing students to retrieve and analyze primary documents (Department of Education, 2000).

Another advantage of using technology is that it provides the teacher the opportunity to work one-on-one with students while others work independently at their own pace. Monk (1989), stated that stand-alone programs are completely self-contained in the sense that they do not require the presence or involvement of an on-site teacher. The internet allows teachers and students to form relationships, learning communities that give teachers the ability to collaborate and learn about strategies that will increase achievement, and promote critical thinking and organization to help students synergize and become better problem solvers. Researchers Bransford, Brown, & Cooking (1999) found that technology can help to create an active environment in which students not only solve problems, but also find their own problems, which is very different from the typical school classrooms. Technology offers powerful tools for addressing (the school's physical) constraints, from video-based problems and computer simulations to electronic communications systems that connect classrooms with communities of practitioners in science, mathematics, and other fields.

For many students, the lack of visual representation of many higher-order concepts makes learning them difficult. Teachers have been limited in what they can teach by the tools to which they have access. New technologies allow teachers to teach complex ideas and address intellectual challenges more easily (Department of Education, 2000).

A survey conducted at Middle Tennessee State University assessed the impact of technology on teaching and learning (Draude & Brace, 1999). Its findings revealed the following:

- Technology helped students better organize their notes and also appealed to different learning styles.
- When technology is utilized effectively, learning is more interesting and fun.
- The effectiveness of technology depends on the teacher. When a teacher lacks creativity and energy, technology is no longer effective.
- Technology helps students prepare for the future.

A recent study was conducted at the Southern University of New Orleans to promote their E-learning program, which was established due to the aftermath of Hurricanes Rita and Katrina (Omar & Kwanbunbumpen, 2008). With so many students displaced, and the campus in ruins, a decision was made to offer courses on-line so that students would not suffer setbacks in their degree efforts. The program proved to be very effective and satisfying to both faculty and students, resulting in an increase in student enrollment of over 2000 students.

Impact of Technology on Student Achievement

There has been a plethora of research on whether and how technology impacts student achievement. Because all technologies are not the same, researchers have to distinguish between technology that students can learn from and technology students can learn with. Students can learn "from" computers – where technology used essentially as tutors and serves to increase students basic skills and knowledge; and can learn "with" computers – where technology is used as a tool that can be applied to a variety of goals in the learning process and can serve as a resource to help develop higher order thinking, creativity and research skills (Reeves, 1998; Ringstaff & Kelley, 2002). A study by the Software and Information Industry Association, Sivin-Kachala and Bialo (2000) reviewed 311 research studies on the effectiveness of technology on student achievement, and found that when students were engaged in technology-rich environments there were significant gains and achievement in all subject areas. Michigan's Freedom to Learn (FTL) initiative, provided middle school students and teachers with wireless laptops, and found that grades improved, motivation and better discipline in classrooms across the state increased (NCREL, 2005). Wenglinsky (1998) noted that technology had a positive impact on the achievement of fourth and eighth graders as measured in NAEP's mathematics test. Wenglinsky also found out those using computers to teach low order thinking skills, such as drill and practice, had a negative impact on academic achievement.

The Milken Exchange on Education Technology used a meta-analysis of research studies to examine the impact of technology on student achievement and found that there were measurable increases in achievement in classrooms where technology is embedded and properly utilized (The Education Alliance, 2005). Being able to access computers and utilize them on a consistent basis is one of the elements present in a modern day classroom. Without adequate access to technology, even the most technologically proficient teachers will not be able to capitalize on the benefits computers bring to the classroom. Those schools with higher computer density per student and higher student access typically show larger achievement gains (Mann, Shakeshaft, Becker, & Kottkamp, 1999; Glennan & Melmed, 1996).

Another important factor that contributes to the successful integration of technology and its impact on student achievement is the amount of preparation and training teachers receive. As teachers expand their knowledge base, and become more comfortable, their ability to implement instructional technology strategies successfully in their classroom will increase. The National Center for Educational Statistics conducted a study and found that teachers who report a high degree of comfort with technology are more likely to use it than teachers who are uncomfortable with it (The Educational Alliance, 2005). Even the International Society for Technology in Education's (ISTE,

2008) Standards for teachers addresses these same concerns. They created five detailed standards that guide the role and responsibility of teachers in utilizing technology in the classroom. These standards are:

- Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.
- Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS.
- Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society.
- Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices.
- Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources.

The expectation of ISTE is for teachers to use technology in every aspect of their job – communicating with parents, collaborating with colleagues, and creating assessments, in addition to providing activities using technology that promote students achievement by engaging students in critical thinking.

A review conducted by Cradler (1995) of research from various students determined that the integration of technology and telecommunications into education produced the following benefits:

- Increases performance when interactivity is prominent
- Increases opportunities for interactivity with instructional programs
- Is more effective with multiple technologies
- Improves attitude and confidence – especially for ‘at risk’ students
- Increases the preparation of students for most careers and vocations
- Significantly improves student problem-solving skills

Studies reviewed by Cradler consistently showed, however, that technology alone does not have a significant impact on teaching and learning unless the following conditions are established:

- Technology and networking should offer opportunities for students to solve problems and construct solutions.
- Technology must give students more control over learning while teachers serve as facilitators.
- Government must promote educationally sound applications of technology and development of software and video programs that meet educational content standards.
- Teachers and administrators must jointly plan for the use of technology and networking.

Furthermore, the Office of Technology Assessment (OTA) has identified the minimum requirements for the effective use of technology in education as:

- Suiting technology to education goals and standards
- Having a vision for the use of technology to support curriculum
- Providing for both in-service and pre-service training
- Ensuring access to appropriate technology
- Providing for administrative support for technology use
- Providing time for teachers to plan and learn how to integrate technology
- Providing for ongoing technical support for technology use

These conditions and requirements will be revisited once the data is collected to explore them as possible rules for selecting technology, one of the components of activity theory, which will be used in this study. Through the lens of this theory each element, the role of the tools, rules, and community environment, will be clearly defined to explain its relationship in the effective integration of technology in a classroom lesson.

The 21st Century Classroom

There is a challenge educators face with today's millennials, which is to bridge together the technological world they live in and the classroom environment we expect them to learn in. Failure to do so would result in a disconnection that affects student motivation, academic performance, and school dropout rates (Wickman, 2009). While technological advancements enhance the look of today's classroom, teachers, who choose to transform their methods of teaching, must be trained to integrate technology by creating richer more interactive lessons. Teachers using technology to enhance learning must be taught not only how to harness new ways of delivering their "product" but also how to measure in new ways the success of their efforts (Keeping the Promise, 1992).

If schools are going to be more effective in the 21st century, a transformation must take place that includes synchronizing instruction more closely to the ways students live and interact outside the classroom, develop curricula that addresses the soft skills required in today's global, information-driven workforce, integrate technology and pedagogy, and look for diverse partners that can add to their pedagogical strengths and help shore up their weaknesses (Christen, 2009). Traditional teaching methods of lecture and note taking is not a natural process with students who are accustomed to text messaging, Internet access and online networking. Technology can act as a catalyst that transforms the classroom into an interactive learning environment, having the power to make the instructor a better facilitator or coach, and bringing greater resources to bear in the classroom and adjusting the instruction to fit the individual (Christen, 2009). Middle school students in North Carolina completed a survey describing their vision for the ideal school. They basically want schools to be a reflection of the world in which they live. They want contemporary environments with aesthetically pleasing designs, colors, and amenities that inspire and motivate them to learn and achieve. They also envisioned using cell phones and laptops during class as a way to look up information on the Internet and having smart boards in every classroom (Spires, Lee, & Turner, 2008).

Factors Influencing the Use of Technology

Byrom & Bingham (2001) examined data from the South East Initiatives Regional Technology in Education Consortium (SEIR-TEC), which gave twelve schools workshops and technical support on technology adoption and integration in their curriculum. As a result substantial progress was made in those schools, and eight lessons learned from this endeavor and suggested steps towards moving technology forward in a school program were offered (Byrom & Bingham, 2001). The first lesson learned is that leadership is the key ingredient if technology integration is to be successful. The participating schools with the most progress had energetic and committed leaders who lead by example, supported the faculty, and used teacher evaluation instruments to encourage development and identify next steps to further extend their use of technology.

The second lesson learned is that every school needs to develop a comprehensive technology plan that supports the school's vision, mission, and goals. The plan must be useful, primarily focused on supporting teaching and learning. To eliminate common problems with implementing a technology plan successfully, the school must have stakeholder buy-in and community involvement, include professional development that covers the wide range of teacher and administrative needs, and decide how to evaluate the effectiveness of the plan.

Thirdly, technology integration does not happen instantly, but is rather a slow process. The Apple Classrooms of Tomorrow studies revealed that technology integration occurred in stages, and the process normally takes three to five years, and even longer in technology-poor schools.

Another lesson learned was that no matter how many computers are available or how much training teachers have had, there are still a substantial amount of teachers who have not made the transition to teach with technology. Byrom and Bingham (2001) suggest using "Features of Effective Learning Experiences", a research-based guide that will increase the likelihood that teachers will begin to use technology. Other effective strategies recommended to promote the use of technology are to use good professional development programs with a wide variety of strategies and use teachers as mentors and coaches.

Lesson five, effective use of technology requires changes in teaching; in turn, the adoption of a new teaching strategy can be a catalyst for technology integration. Technology alone does not improve student achievement. It is the combination of effective pedagogical practices as well as appropriate technologies that lead to student achievement. Byrom & Bingham (2001) found that it is more effective to use a particular teaching strategy that teachers believe students will benefit from to engage teachers and help them discover how to support the strategy using technology.

Each school needs easy access to professionals with expertise in technology and pedagogy. Lesson six finds the need to have someone on site to support the staff with technology integration and operation issues. If this person is not available, it is suggested that the administration document the amount of requests made in order to gauge the need to add someone on a full-time basis.

Barriers to using technology to support learning are the same for all economically disadvantaged communities, but some populations have additional issues. Byrom & Bingham (2001) identified such barriers that affect the implementation of technology as old buildings with leaking roofs, electrical wiring problems, lack of security, high staff turnover, and limited resources. To overcome some of these barriers, first identify the educational problem that technology can help solve and focus on that problem; find out how others with similar problems are addressing them; and learn what resources are available and advocate for the products needed.

Finally, evaluation is often the weakest element of technology programs (Byrom & Bingham, 2001). There are several reasons why the evaluation component is such a small aspect in technology plans. First of all, the developers of the technology plan may lack experience in designing an effective evaluation that will yield meaningful results. In addition a project budget should normally set aside ten percent to spend on evaluation. Very often, however, the money ends up being spent on acquiring staff or professional development. Lastly, finding a good evaluator is difficult, because there aren't many educators who have the expertise in evaluating a program and with integrating technology. Rather than eliminating the evaluation process, lesson eight's recommended action steps include first of all viewing evaluation as a way of documenting success and identifying growth opportunities. For each goal listed in the plan, the evaluator should identify at least one question to evaluate its level of progress, have evaluation tools readily available, be willing to modify the tools to fit your plan, and always reflect on your progress.

Teaching The 21st Century Student – 'The Millennial Child' – 'Digital Native'

The term millennial was validated by a survey conducted in 1999 by Strauss and Howe of students in the Fairfax County, Virginia, school system (Junginger, 2008). Fifty-six percent of the students preferred the label millennial generation, because they are the first generation to reach adulthood in the new millennium. They came of age in the 1990s when the technology revolution exploded and, therefore, are extremely technologically sophisticated.

Prensky came along in 2001 and labeled this generation “digital natives”, and the generations prior to them “digital immigrants” because they adapted to technology as it was introduced into our society (Prensky, 2001). Digitial natives understand the language of technology and have no concept of life without various technology tools. When they were born cell phones, MP3 players, digital cameras, Wii and Nintendo game sets, laptop computers, and iPods were already part of the normal function in society.

Educating the millennium generation, those children born after 1992, is quite a challenge from the past and requires different teaching techniques. They grew up in a time of largely uninterrupted economic prosperity; they’re the most protected generation in history, in terms of government and safety regulations; and they’re used to being indulged and consulted on family decisions (McGlynn, 2005). Millennial children were the first generation to grow up in the digital age, and therefore, thanks to cell phones, text-messaging devices, and e-mail, are better connected both to their parents and to each other. Because of these characteristics, these millennial children learn better with strategies that allow them to be decision makers and work cooperatively with each other. They have a preference to learn in their own time, and on their own terms. They seem to appreciate structured activities that permit creativity. They want to be involved in ‘real life’ issues that matter to them (McGlynn, 2005). Millennials can absorb information quicker, and they reach boredom sooner when subjected to traditional teaching methods (Junginger, 2008). They want to learn by using teamwork, technology, structure, entertainment, excitement, and experiential activities. Schools must discard traditional learning and teaching methods and embrace new, technology-driven teaching by revamping the curriculum and using advancing technology in their presentations. Millennials have excellent visual-spatial skills. They understand multidimensional visual space, which is profoundly important in web site design (Levey, 2008).

A study conducted in a North Carolina Statewide After-School Program surveyed 4,000 students on the activities they liked best in school (Spires, Lee, & Turner, 2008). The activities rated included working on projects by themselves, doing research on the Internet, listening to the teacher explain things, working on projects in a group, using computers, and doing worksheets. The results revealed that students prefer using computers and doing research on the Internet as their favorite activities, while listening to the teacher explain things and doing worksheets as their least favorite activities.

Successful Teaching

There was once a time when researchers believed that behavior characteristic of successful teachers could not be identified, and research failed to produce useful results to describe good teaching, suggesting that the research was socially biased (Turner, 1964; Goheen, 1966; Broudy, 1969). There were, however, researchers during that same era who identified two traits most common among successful teachers – flexibility and warmth. Flanders (1960) found that at times a teacher may need to be an authoritarian, while at other times the teacher may assume a more democratic role. Nonetheless, the teacher's ability to be flexible was a contributing factor of good teaching, which resulted in student achievement. Other researchers found similar results. Heil, Powell, & Feifer (1960) discovered that healthy, well-rounded, and specifically flexible teachers were successful teachers as measured by student achievement. Other researchers noticed that students are motivated and take greater interest in the core subject with teachers who are warm and friendly (Reed, 1962; Getzels & Jackson, 1963).

More recently, Brown (2003) conducted a study of 13 teachers in urban school settings, seeking to understand their classroom management system. He concluded that teachers who create a caring classroom environment by showing interest in the students, and display assertiveness, mutual respect, and effective communication give students a greater opportunity for success.

In order to increase the use of technology in the curriculum, Geoghegan (1994) identifies five needs that must be addressed as follows:

- Need for recognition and process involvement
- Need for vertical support structure to overcome technophobia
- Need for well-defined purpose or reason
- Need for ease of use and low risk of failure
- Need for institutional/administrative advocacy and commitment

Several studies on factors which affect teachers' use of technology have been conducted in prior years. Sheingold (1990), Wang and Chan (1995), Braak (2001), and Wetzel (2001) have investigated significant influences of technology integration into the classroom. Jaffe (1998), studied the resistance to asynchronous learning networks (ALN), which utilizes internet/web-based learning applications. He concluded that the cultural tradition of classroom teaching is a major factor to the reluctance in adopting ALN technology. Garry (2001), conducted a study which revealed that before teachers can begin utilizing the Internet as a curriculum resource tool they must possess a positive attitude towards technology integration and a willingness to acquire the skills to use the web. According to Sion (1998), Lewis (1998), and Baker and Blue (1999), appropriate use of Internet resources in the classroom produced an increase in student performance and provided teachers with a powerful tool for communication, collecting information, and presentation. In addition, Rakes and Casey (2002) discovered that providing teachers with an understanding of technology as a curriculum delivery method, ensuring teachers' comfort with tangible technology, and helping them to make a paradigm shift allowed teachers to embrace possibilities that technology brings to the classroom of the future. Fleming's study (1992) of 596 Canadian teachers' views on technology and society suggested that teachers overwhelmingly took an artifact or tool perspective on technology, and the majority held an incomplete view of the nature of technology. Most of them felt technology was beyond the control of the individual.

A nationwide study of teachers in grades 4 through 12 who are experienced and accomplished at using technology in the classroom were surveyed to discover their teaching practices and the barriers and incentives that are significant to them (Sheingold & Hadley, 1990). The results of this study revealed that:

- Teachers are comfortable with using technology, and devote time outside of the classroom to learn how to use it. They also receive training and additional support towards its use.
- Teachers are able to present more complex materials to students, expect students to use technology and promote student independence in the classroom.
- Teachers work in schools that have far more technology resources than other schools.

- Teachers use the computer for various tasks – word processing, demonstrations, instruction, and project-based activities.
- Teachers who use technology well developed over a five to six year period.
- Teachers identify barriers to integrating technology as inadequate amounts of hardware and insufficient time to plan and implement lessons.

Implementing Technology Effectively

Kent (2008) developed a six-step plan for teachers to be successful with using technology. First, the teacher should understand why it is important to use technology in today's classroom. He continues that teachers must be open-minded and willing to adapt to having technology as a support tool. The next step is to plan for technology by knowing what is available, knowing what the district policy and guidelines are, selecting what fits you, and taking action. Teachers should do their homework and find out the security guidelines, and understand how to use the technology they have selected. The final steps are to implement effectively, which is described in depth below, and keep up to date with technology as it changes.

Kent (2008) believes the key to using technology effectively in the classroom is to make sure all the support is in place and being at your best when teaching. In other words, technology alone does not guarantee the lesson will be effective. The teacher must have the equipment, be knowledgeable of how to use the equipment, and be competent in the content area to deliver instruction effectively to students. His (Kent) organized plan for delivering instruction successfully with technology requires the following:

- Understand the hardware, software, and website options available.
- Add variety. Overuse of one type or not using its full potential can limit student learning. Therefore, use multiple resources that keep students focused without overwhelming them.
- Take breaks. Too much time on one activity may get students off task. Limit the use of one technology or break up into parts to keep students focused.
- Encourage student involvement. This may be accomplished by creating learning stations in the classroom, assigning projects that require students to use technology, giving students free time to use technology, or designate students to facilitate the use of technology.
- Use technology to improve assessments in your classroom. This may include using student-response systems or online activities that automatically score the assessments upon completion. The teacher may also use computer-based tools to store data collected on students' performance.
- Have fun. Maintain a positive attitude and be open to explore and create those learning experiences others may find enjoyable.

Kent has methodically outlined steps to benefit teachers who want to transform their teaching practices from chalkboard to whiteboard, and from routine drill and practice to interactive engagement. As data is collected and analyzed in this study, the researcher may be able to recognize one or more of these steps from the participants.

Other Research on Technology

The No Child Left Behind Act (NCLB) required all school systems to establish technology literacy for every student by eighth grade regardless of the student's race, ethnicity, gender, family income, geographic location, or disability (U. S. Department of Education, 2001), and in 2002 the U. S. Department of Education called for a study of technology effectiveness. Not only are they conducting research, but numerous studies on technology have been conducted for more than a decade to evaluate various software products, uses of technology, technology training for pre-service and veteran teachers, and the correlation of technology and student achievement. Interestingly, there are two studies worth mentioning because their focus is linked to what this research study is about. The first one explores how teachers effectively integrate technology, and the second one examined how teachers decided to use technology in the classroom.

In an Idaho school district, teachers were asked to explain how technology should be implemented in the classroom. They found seven steps to be effective in utilizing technology. After choosing a core subject, decide what technology skills you want to teach or could be best taught in this area; choose one lesson or unit that could be enhanced or taught through the computer; develop that one lesson or unit in a software package or medium you know very well; use it; evaluate how it went; refine the lesson and/or start with the next lesson or unit (Dockstader, 1999).

A study was conducted in 2006 of elementary and middle school teachers to identify predominant factors influencing teachers' decisions to use technology in the classroom setting (Baek, Jung, & Kim, 2006). Six factors emerged as a result. The leading factor reported was adapting to external requests and others' expectations. Most teachers felt that they would be perceived as a 'good teacher' if they used technology with their lesson, or feel uncomfortable if they didn't use technology because most of their colleagues used it. The second factor, deriving attention, was explained as technology motivating and stimulating student interest. Teachers reported that they can get students' attention to learning content by using technology. The third factor is using the basic functions of technology. Teachers, in this case, use technology because it allows them to easily manipulate digital materials for copying, editing, and sharing. It is a convenient way to reorganize or reuse material, and it increases communication with students and parents through the school web site. The fourth reason teachers decide to use technology is to relieve physical fatigue. Teachers reported that using technology serves as a substitute for teaching to allow them to do routine work, or give them a break from teaching. Class preparation and management was the fifth factor that relates to why teachers decide to use technology. Teachers find that using information found on the internet make it easy to manage teaching materials and prepare content activities. The last factor, using the enhanced functions of technology, allows teachers to simulate experiments that are difficult to do in the regular classroom.

While both studies discuss teachers' use of technology in the classroom, the first study is a generic process for all teachers to use without specific details of who the students are, or what the learning outcome should be. The second study only evaluates why teachers use technology. There is no consideration of its effectiveness in the classroom or details on how to use technology. This study, however, will explain what teachers do when utilizing technology effectively in the classroom.

Chapter 3

METHODOLOGY AND RESEARCH DESIGN

This chapter describes the methodological design used to conduct this study. As stated earlier in chapter one, the purpose of this study is to investigate technology strategies used by mathematics teachers in the classroom by answering the focus questions: How do successful middle grades mathematics teachers of urban learners who use technology effectively, describe their teaching practices; and What are the strategies teachers use when implementing technology? In order to answer these questions qualitative study using case study research methods was used. Qualitative research basically helps us explain the meaning of social phenomena and understand it better with minimal disruption to the natural setting (Merriam, 2001). In this study I want the reader to gain a thorough understanding of the participants' strategies and experiences so that other teachers will be able to identify and adopt their procedures, and thereby, increase the population of teachers using technology with their instruction. Qualitative research allowed me to capture the complex nature of the planning, selection, and implementation process teachers of urban middle school mathematics experience.

According to its characteristics, I have determined that case study methodology was most appropriate for this study. A case study is defined as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2003). Case studies have various applications. They can be used to explain, describe, illustrate, explore, or evaluate details from real-life, cause and effect situations that are not captured in surveys and quantitative analysis. While there are several types of case study applications, this study used a descriptive approach to report on teachers' use of technology and the real-life context in which it occurred. That is, as the researcher, I enlighten the reader's understanding of how teachers use technology by describing those conditions and practices that influence effectiveness using thick rick description of each case.

Case studies can also have a single-case design or multiple-case design. Single-case research is particularly appealing to researchers and practitioners in education and psychology because it is based on an interest in the effectiveness of an intervention for a single, particular individual (Mertens, 1998). Multiple case study designs are used when the researcher replicates an experiment over and over and is expecting similar results, which strengthens the external validity of results. Single- case studies are best utilized when the case is thought to be critical or unique in some way, and the researcher wants to test the theory or analyze and document its occurrence. Some single-case studies are longitudinal, meaning that the researcher wants to examine the same case at two or more different points in time to analyze how circumstances change over a period of time. Single-case studies may also be revelatory, in which the researcher observes and analyzes a phenomenon others had no access to previously. Other single-cases are considered representative or typical. The objective in these cases is to capture the circumstances and conditions of an everyday or commonplace situation (Yin, 2003).

Another distinction in designing a case study is to choose holistic versus an embedded study. An embedded study contains subunits within the study. These subunits may be different levels within an entity being studied and may require different units of analysis. Holistic case studies examine the global nature of the entity being studied. The holistic design is favorable if there are no other subunits identified or when the theory guiding the case study is holistic in itself. Yin recognizes, however, potential problems with the holistic design being that it could lack any clear measures of data, or the nature of the study may shift during the research. To avoid this shifting, an embedded design with subunits gives the researcher flexibility and prepare the researcher for evidence that emerges without having to start over.

Based on all of the case study characteristics mentioned above, this study was conducted using single-case methodology and a holistic approach to depict the process of technology integration. As a single-case study, three urban middle school mathematics teachers were investigated solely for the purposes of describing the nature of their effective practices using technology in the classroom. This study did not test whether teachers use technology; nor did it test the actual software used. The researcher reported on teachers' strategies for selecting and using technology to advance learning outcomes.

In addition to the aforementioned elements characterizing this case study, Yin identified five components of case study research design. The first component in each study is to have a research question to guide the study. Secondly, it must also state its propositions, which are statements directing attention to something specifically examined within the scope of the study. Next is its unit of analysis, where the researcher identifies the case, followed by establishing the logic linking the data to the proposition, which is when the researcher describes how the data will be used to illuminate the propositions. The last component is the criteria for interpreting the findings. The research questions for this study were: (1) How do successful middle grades mathematics teachers of urban learners who use technology effectively, describe their teaching practices? (2) What strategies do teachers use when integrating technology effectively in the classroom? In lieu of propositions, Yin (2003), says the researcher should identify the purpose of the study and the criteria by which an exploration will be judged successful. The purpose of this study was to investigate effective use of technology by successful teachers in urban middle schools as a tool for advancing mathematics achievement in the classroom. The unit of analysis established the boundaries of the case study. This study was bounded by teaching episodes of veteran middle school teachers who have taught in an urban public school setting for three years or more. The data collected included direct classroom observations, lesson plans, and audio taped interviews. From this data the researcher looked for common patterns of behavior from each participant in the study to identify as an effective strategy for integrating technology in the classroom. Unique behavior was also identified as an effective strategy as it pertained to the integration of technology students are learning with.

Participants

In order to complete my research, I used purposive sampling to select three mathematics teachers of urban middle school students. These teachers were selected from referrals by the math coaches, model teacher leaders, and principals of a large urban school district who successfully utilize technology in the classroom on a consistent basis.

A consistent basis means that each time a new skill is introduced, modeled, practiced, or assessed, technology integration was used effectively to advance learning outcomes. Teachers participating in this study are 'successful' teachers, with a minimum of three years teaching experience. A successful teacher is defined as the teacher who has high expectations of students, uses the curriculum as a guide to select appropriate methods, strategies, and materials to engage students in meaningful activities that lead to student achievement. All participants selected had a minimum of three years experience because that is the requirement for tenure. The teacher has had time to settle in their position and more likely to be committed to the education profession.

A total of nine Math coaches, model teacher leaders, and principals combined were contacted via email for recommendations of teachers meeting the criteria. From those contacts five responded with names of six teachers. One of the teachers was eliminated for consideration due to being transferred to another school outside of the schools listed in the approved IRB. All of the remaining teachers recommended were contacted via email and invited to an initial screening where they were asked a series of questions to determine eligibility for this study. All met the criteria for the study. However, one teacher was not selected due to badly damaged equipment in her classroom at the time data was collected. Of the remaining four participants, all African-American, one was eliminated based on the need to have diversity among the participants. There was one sixth grade teacher, two seventh grade teachers, and one eighth grade male teacher recommended in the sampling pool. Two of the teachers, one seventh and one eighth grade, taught at the same school. Since I had no other males and no other eighth grade teachers in the sampling, the seventh grade teacher at the same school as the eighth grade teacher was eliminated in order to capture technology used with a variety of curriculum standards in different environments. All participants, who remain anonymous, were middle school mathematics teachers in a typical classroom setting of 18 students or more. Each participant is described in detail in the next chapter. The participants are listed in Table 4 below.

Table 4

Participants Profile

Pseudonyms	Gender	Yrs. Of Service	Pseudonyms	Grade	Personal Technology Usage
Ms. Anniston	F	23	Concord Middle	6	Blackberry cell phone Pays bills on-line Digital Photo Imaging
Ms. Bell	F	8	Riverstone Middle	7	Blackberry cell phone Pays bills on-line MacBook Ipad
Mr. Jacobs	M	7	Timberwood Middle	8	3G smart phone Pays bills on-line 2 laptops I-pod Nintendo Wii Xbox 360 Facebook; Myspace

Data Sources and Data Collection Procedures

Data was collected in phases over a semester school term in order to observe technology used with a variety of curriculum standards. Collecting data required me taking time off to complete afternoon interviews and scheduled observations because I am also employed in the same school district. Each principal at the approved school named in my IRB application to the school district received a copy of the IRB approval letter, creating a more manageable opportunity to collect data. I then submitted a schedule to my principal of dates and times I would need away from my school to collect data, assuring him that it would not interfere with critical dates or events, nor create a hardship in my productivity. I contacted each principal at the schools where the participants work to explain my purpose and discuss visitor rules and regulations. One principal was difficult to reach. However, because I maintained constant communication with the participant, I had no conflicts with scheduling, and felt comfortable about proceeding with the classroom observations.

The first phase of data collection involved conducting the initial interview. Merriam (1998) suggests open-ended and semi-structured interviews. These type interviews are useful when the researcher gathers information from the participant's viewpoint about a situation. The initial interview allowed me to introduce myself, explain the study, address any questions or concerns the participant may have, and obtain consent from the participant (see appendix A). The interview proceeded with questions about their use of technology, and what they say and do in the classroom (see appendix

B). Their responses were used to help guide the development of questions for interviews in the next phase. Interviews were audio taped and conducted with each participant separately, at their school, at the end of the school day and transcribed later.

The next phase documented what I observed the participants actually doing in the classroom. I observed each participant using technology with two different math standards that is required according to the mathematics curriculum for their grade level. These observations were documented manually using field notes to record what took place as the teacher used technology. Neither audio nor videotaping was permitted during classroom instruction according to the IRB guidelines set by the school district where the data was collected. Each participant and I agreed on the day and time I would observe a lesson so that I could schedule the necessary time off.

After each observation, the researcher conducted a follow-up interview with each participant to discuss reflections concerning the implementation of the technology and its effectiveness. The data collected in this phase reveal how the technology was selected, if the teacher's lesson plan matched the actual events and classroom practice, and if the technology implemented assisted the teacher in accomplishing the curriculum goal.

The final phase was a summarized interview with each participant to discuss and get clarity on any discrepancies between the initial interview and the observations. Data sources from each participant included six interviews, lasting approximately 30 minutes each, two one-hour classroom observations with each participant, and participants' lesson plans as evidence of their use of technology.

Role of the Researcher

At the time of this research I am a mathematics educator of predominately African-American, economically disadvantaged middle school students in an urban school district. I entered my teaching career over fifteen years ago with more technology skills than the average teacher because my prior occupation as a financial analyst in the corporate sector required the constant use of a computer or some advance form of technology such as video conferencing and LCD projection. With a plethora of technology resources now available, I desire to know a structured outline or pathway to knowing when and how to integrate technology effectively. I work with a large and somewhat diverse population of teachers who appear to be competent in their content area. Some of them utilize technology in their daily lesson activities and some do not. Those who use technology may be using it as a communication tool, or as remediation support. There are teachers who navigate quickly and with ease through the internet to locate useful resources and activities; then there are others who have trouble logging on to a computer. Some teachers attend local seminars and workshops to keep abreast on the latest technology while others still use traditional teaching methods (even though they are aware of their annual evaluation includes providing evidence of technology use in the classroom). I have observed in my own classroom more student engagement in activities when technology is used; however, I also noticed students get bored and resort to off-task behavior when the activity requiring the use of technology becomes routine, which signifies an ineffective use of technology. Therefore, my research will help me understand the process utilized by teachers who integrate technology successfully in the classroom.

Researchers have investigated the impact of technology in the classroom and have found a direct correlation in student achievement. In addition, students also tend to be more engaged and take ownership of their learning, purging the use of passive learning in the classroom. In order for these results to be achieved, applications must be appropriately selected by the teacher that will promote learning and reach individual students where they are (Hancock, 1993).

I believe that teachers who provide a balanced instruction – combining technology with elements of writing and real-world problems have a better understanding of experiences and tools students need to be successful in their future, and prepare them accordingly. Based on my experience, I believe that chronological age, years of teaching experience, size of family, and personal interest are factors that influence teacher knowledge and use of technology.

I believe teachers who use some form of technology constantly throughout the day, whether at work, or at their leisure, will promote the use of technology in their classroom. Teachers who enjoy the latest technological inventions for modern convenience will approach new educational technology with an open mind and rationalize the use of it in the classroom. I also believe that veteran teachers with more that twenty years of teaching experience will be apprehensive about using technology because it is difficult for them to accept change.

My role as a researcher was that of a direct observer in the classroom. I served as the data collection instrument, conducting semi-structured interviews and classroom observations. While there was no interaction with teacher or students during the regular class time, my presence may have slightly affected their behavior, and consequently changed the level of student interaction. However, my presence had no impact on teacher knowledge and usage of technology. My interaction with teachers occurred in their spare time, either after school hours or during the teacher's planning time.

Data Analysis

Qualitative data analysis is defined as an ongoing process involving continual reflection about the data, asking analytic questions, and writing memos throughout the study. It involves using open-ended data from the information supplied by the participants of the study to make an interpretation of the larger meaning of the data (Rossman & Rallis, 1998; Creswell, 2003). The data analysis I used follows the six-step generic approach recommended by Creswell, which involved 1) organizing and preparing the data analysis by transcribing interviews, sorting and categorizing the data; 2) reading through all the data to reflect its overall meaning; 3) coding the data; 4) use the coding process to generate a description of the people, places, and events of the study; 5) describe those themes in a narrative passage or table; 6) make an interpretation of the data. Upon collecting data from the participants, I personally transcribed the interviews and looked for patterns and striking differences among the participants to derive specific and optional methods and strategies lending it as best practices for all teachers. The use of activity theory also enabled me to organize the data and analyze the process involved in teachers using technology effectively, which I describe later in chapter 4.

Trustworthiness of Data

It is important that the researcher explain the process by which the findings in the study are validated. .According to Lincoln and Guba, (2000), there are four criteria that determine the trustworthiness of the data collected and reported in a qualitative study. Following these criteria, I employed the use of credibility, transferability, confirmability, and dependability throughout this research process.

Credibility

In this study I used prolonged engagement and member checking to establish credibility. Prolonged engagement was used as I observed participants over a semester period in order to understand the actions of teachers who integrate technology in their lesson. By using prolonged engagement, it allowed me to establish trust with the participants, ensuring their autonomy to perform routine activities documented in this study. Member checking was also used to ensure my interpretations of reality and meaning hold truth to the data collected. At the conclusion of this study, each participant was allowed to review my findings to match their experience with the data collected and confirm the accuracy of my interpretations.

Transferability

Transferability refers to the ability of the researcher to extend the findings of a study beyond the specific individuals and setting in which that study occurred. This study took place over a four-month period in an urban school district. In order to establish transferability, I presented rich, thick, detailed descriptions so that the audience would understand the contextual variables operating within this setting and have a solid framework for comparison (Merriam, 2009).

Confirmability

Confirmability warrants that the data reflect the views of the participants accurately rather than the researcher's biases. I maintained an audit trail to trace the data to its original sources. Using interviews, observations, and analysis as multiple data sources, triangulation was employed as a process of cross checking data to ensure trustworthiness. Data was manually coded using process and axial coding procedures (Corbin & Strauss, 2008), to organize data meaningfully and label categories readers will be able to understand. Each coding cycle is demonstrated in Tables 5 and 6. In the first cycle (table 5), the qualitative researcher describes actions and interactions leading to solutions to problem solving. With technology strategies as the goal in mind, each response given by the participant and each action observed was coded using action verbs. In the second cycle I used the axial coding method, shown in table 6. Axial coding allowed the researcher to group those actions (process codes) together that contained a common attribute and categorize them in order to capture the nature of the events that occurred and answer the research question. The results are presented and discussed in chapter 4.

Table 5

Sample Process Coding Method

Interview Question	Participant Response	Process Code
How was technology used to support instruction?	It allowed the student to click on a relation and drag it to the box that was titled ‘a function’ or ‘not a function’.	Interacting with software
What worked well with this lesson?	Students were able to move at their own pace; it allowed them to see their scores, and it gave immediate feedback.	Assessing student learning
Describe your approach to using technology.	I go home every night and look for things I can use in my classroom.	Searching for interactive technology.

Table 6

Sample Axial Coding Method

Preparation	Evaluation
Previewing the night before	Evaluating for understanding
Planning for variety	Discussing
Searching for interactive lessons	Saving and modifying for other learners
Checking equipment	Using activotes for assessments

Dependability

Dependability is a characteristic stating that if this study was conducted at a later time by another researcher using the same procedures, the results should be the same. By minimizing researcher biases, and implementing the strategies – prolonged engagement, member checking, thick description, and triangulation, the dependability of this study was established.

Chapter 4

Analysis and Findings

In this chapter I present the cases of three successful mathematics teachers who use technology in their classroom using data collected over a four month period from lesson plans, interviews, and observations. Organized by participant, I present their data in five parts. The first part gives a little background on each participant, followed by the interview where the teacher describes their process of selecting the technology they use and their teaching practices. The next two parts details my classroom observation that supports the information teachers gave about their teaching practice. The focus of the observation was primarily to see the teachers' use of technology in action (which is called an episode), as well as verify the accuracy of what they say about their instructional practices. Each episode begins with the episode trigger (stated from the lesson plan), the activities where technology is used, and the outcome (how students respond to activities). The final section reveals the teachers' summarized description of using technology effectively. Pseudonyms are used for each participant and their school to protect their identity.

The goal of this research is to describe strategies teachers use to implement technology effectively in the classroom. The following research questions were used to guide the data collection and analysis: (1) How do successful urban middle grades mathematics teachers who use technology effectively, describe their teaching practices?

(2) What strategies do teachers use when integrating technology effectively in the classroom? The synthesis of each participant in this case study will answer the research question.

Ms. Anniston

Background

When you enter into Ms. Anniston's room at Concord Middle School, there is a powerful feeling that lets you know students are focused on a specific goal or task to accomplish, as if they are in search of a precious treasure, and with intensity, they are bound to find it before leaving that classroom. Ms Anniston has a doctorate degree in Teaching and Learning, and is a veteran teacher of 23 years. She has taught at her present school for 18 years and currently teaches sixth grade mathematics. She is a successful teacher because she is dedicated to working with children as much as needed until they learn the math skills in the curriculum. This is evidenced by the amount of time she spends not just on the required afternoons for tutorial, but availing herself any day of the week to her students. The annual standardized test scores of her students average approximately 80% or higher. Just outside of her classroom Ms. Anniston displays mathematical tasks and projects students have completed along with photos of the students while working on specific tasks.

She has witnessed her school undergo several renovations and technology upgrades. Her class was the only room at her school to receive a workstation of 15 computers so that students could use the internet for math projects and geometer's sketchpad for skill mastery. She was also the first teacher at her school to receive a promethean whiteboard so that various applications of technology would aid students' visual understanding of the geometry standards required in her school district. Today, Ms. Anniston's classroom has a technology station containing six desktop computers located on one side of the classroom. In the front of the classroom is a promethean board mounted in the center of a white, dry erase board. An LCD projector is mounted from the ceiling, and her laptop is located at a nearby table. Her classroom has 28 desks divided into two separate sections of 14 desks each, side-by-side, and facing each other. This arrangement lends itself to working cooperatively on mini tasks, and allows ease of board visibility as well as mobility.

Ms. Anniston – Technology Planning

Researcher: Describe your approach to selecting technology.

Ms. Anniston: The school has provided it for us and it is something I am interested in. So I go home every night and look for things I can use in my classroom. Right now I am putting Math Navigator using flip charts on the promethean board. I try to find creative flipcharts created by other teachers or I create them myself.

Researcher: What is Math Navigator?

Ms. Anniston: Math Navigator is an intervention program the district has purchased to help students who are currently performing below grade level. If students did not pass our state standardized test, they were tagged for this intervention program. After using it for a few weeks I liked it and decided to use it along with our text during regular instruction as reinforcement.

Researcher: Is the technology selected during the time you are creating weekly lesson plans? If not, when?

Ms. Anniston: No. I search every night.

Researcher: What types of technology do you use?

Ms. Anniston: I use the promethean board, my laptop and the LCD projector daily. Sometimes I use the Activotes with the promethean board. I also use the Mac Cart, which is a portable computer lab with 30 laptop computers we can check out of the library.

Researcher: Why do you use technology?

Ms. Anniston: We have students born in the digital age and they are a different type of learner; and in order to keep their interest we have to use technology. The things we do on the white boards we could never do on the overhead; it's more interactive; you can save student work and teacher notes. Students don't like to use paper and pencil so I have something for students to do. They like to write on the board cause other teachers won't let them.

Researcher: How do you know when to use technology during your instruction?

Ms. Anniston: It is necessary that I always use technology. I use it consistently throughout the lesson. I can go back and enhance it and reuse it with other classes because unlike the old chalkboards, I can save my information and always go back and retrieve the notes and activities. There are some things that I need to do differently, depending on the kind of lesson I am preparing.

Researcher: What do you have to consider when you are preparing your lesson?

Ms. Anniston: I always look for activities that are interactive, because it helps students focus more. The difference is the kind of problems I look for. I vary the problems according to the level of difficulty. Some students move at a more rapid pace than others, so I have to find something that challenges everyone where they are. If I am preparing for a review, I look for multiple choice items that will allow me to use the Activotes. Those Activotes are designed to help me see where my students are and what misconceptions they have. That way I can redirect their thinking so they can perform better on assessments.

Researcher: What's the next step from the time you see this is what you want to use? Are there any specifics you are looking for to increase the amount of engagement?

Ms. Anniston: Yes, there are. I like colors. I learned long time ago that colors do things to some students. It gets them excited because just plain white I feel like is boring to some students. They like movement. They like coming to the promethean board. Two students can come up at one time. Sometimes it may not work the way I want it to; so I have to go back and add something. Sometimes I can change things within the class period and sometimes I have to come back the next day; but I always try to do it myself as a teacher acting like a student the night before, before I present it to the students so I will know what the students have to go through.

Researcher: How is the Mac Cart used in your classroom?

Ms. Anniston: I use it with my assessments. After we have finished a unit I will give them a test to see how well they perform. Also, because the computer lab is on the other side of the building, and so many other classes use it, it is easier for me to access the Mac Cart and stay in my room. They can take the same online assessments that I have created from the state standardized item bank in class. They could also use the macbooks to do research, but I have not given them any research yet, because I really want to monitor students. I don't want students to just go on the laptops and do research unless I have specific websites I want them to go to. I'm sure the school system has some type of filter. I want to make sure when I tell them to do research they have specific websites to go to.

Researcher: How do you evaluate students' progress when you use technology?

Ms. Anniston: Mainly, with the computers it has to be something with multiple choice. With the website I have called Class marker, I can put in constructive response questions, but I haven't moved to that level yet with my students. So now it's a big task for me to just key in multiple choice items.

Ms. Anniston – Episode One

According to their curriculum pacing guide, sixth grade teachers were reviewing fractions and teaching students to perform the four basic operations using fractions. In the latter part of a crisp autumn school day 24 sixth graders paraded into Ms. Anniston's room, some racing to their seat to copy the assignment from the board. Leading the headline across the top of the promethean board screen was the objective. It reads 'The student will solve problems involving fractions with 80% mastery". It was followed by a question for the students to answer before leaving that day. "How can I find fractional parts of areas?" scrolled by for about the first half hour of the class period. The board was vibrant in bold colors.

At the beginning of the lesson while students passed out rulers Ms. Anniston reviewed the vocabulary words – area, figure, equal area, and same shape on the screen. The first assignment stated on the promethean board was as follows:

Assignment #1: Use a ruler to sketch a line segment that is:

a. 4 inches long, label the endpoints 0 and 1.
b. divide the line into eight equal parts.
c. what fractional parts does your line segment show?
d. How long is each fractional part?
e. How long is one whole unit (from 0 to 1 on the number line) in inches?

While students followed directions on a clean sheet of paper, volunteers went to the board, and using their ruler and the promethean pen, constructed a line four inches long with eight equal sections separated by a short vertical mark. Although students wanted to label each mark with a counting number, Ms. Anniston reminded them of the directions, which were still posted on the board. In small groups, the students decided how the marks dividing each segment should be labeled. Most of them successfully labeled each segment as one-eighth.

Satisfied that students understood fractional parts of a whole on a ruler, Ms. Anniston proceeded to the second assignment. She flipped to a new page on the screen. Students wrote:

Assignment #2: What do you know about the area of a figure?

1. Show two ways to shade ½ of the area of a square .
2. Show how you shaded. How do you know it is half?

Ms. Anniston wanted volunteers to display two different ways the square could be divided in half. Two students went to the board to show their work after practicing at their seat. Because Ms. Anniston had two promethean board pens, the students could work without waiting on the other to finish. They proudly displayed their name next to their board work. Afterward, students stepped aside to view their work before describing orally what they did to complete the assignment. The entire class observed each student's work and agreed with the two diagrams.

One student divided the square by drawing a vertical line through the middle of the square. The other divided the square by drawing a horizontal line from the middle left side of the square to the middle right side of the square. Each student explained that folding the square on the line drawn would prove that the square was divided in half because you would then have two equal parts. The next page that followed showed two more squares with a portion uniquely outlined and shaded. Ms. Anniston asked students if the shaded region was half of the square. If so, how could they prove it? After allowing them to briefly discuss their answers, Ms. Anniston explained that if they separated the shaded and unshaded portions, they would be able to fill one with the other without any overlap. As she talked it through, the colorful diagram on the board separated the parts and shifted around to show how they matched as two equal parts. We were all amazed!

The final page on the promethean board showed the homework assignment. It was written in bold lettering and various coloring. Their assignment was to compare and contrast a) a point at ½ on a number line from 0 to 1 with b) half of the area of a square.

Researcher: What made the use of this technology effective for this lesson?

Ms. Anniston: Students learn from each other. It promotes more dialog among them. Some students who would never participate in class want to come to the board to show what they know. It was engaging for them.

Ms. Anniston - Episode Two

The standard was Number and Operations and broken down to finding factors and multiples, the greatest common factor, the least common multiple, and prime factorization. These were the elements listed under the standard and from these the teacher created 7 different tests. The teacher distributed to each student a Mac Book laptop computer by number. The students took several tests in the classroom instead of going to the interactive computer lab because Ms. Anniston decided the students should have their own laptop computer to complete their assessments for that day. Once students received their laptop their name was logged in by Ms. Anniston to identify the student and the numbered laptop. Students began working. Some were able to log in and go directly to the assignment. A few had problems with their computer; but Ms. Anniston had the technician in the room to assist with any login issues that arose. Soon everyone was working at their desk completing their assignment. On occasion students used scratch paper to calculate answers. Students completed the online assessments at different times, but they proceeded to go to the website created for the class by Ms. Anniston to take a different assessment, view their scores, and write a reflection about their knowledge and experience with Number and Operations.

Ms. Anniston – Effectiveness of Technology

Researcher: What made the use of this technology effective for this lesson?

Ms. Anniston: Since we have a database for Online Assessments available and we have laptop computers available that made it individualized for each student. It worked very well. The students were able to move at their own pace and they were excited about using the laptop computers. They were able to see their scores at the end of the lesson where if they were using a workbook they would have to wait until we check papers. Technology allows the students to get immediate feedback. They could go back and see the problems they got wrong and study and try to figure out why they got that particular problem wrong.

Researcher: The way your classroom is arranged what is your policy or how do you know they are not sharing answers?

Ms. Anniston: My class is large and they are sitting in pods of four. And the rule is they are not supposed to look at anybody else's laptop, they are not supposed to help anybody, and the test I have on class marker its randomized; so two people sitting next to each other should not have the same problem at the same time because the program is supposed to randomly present the problems.

Researcher: One of the assessments they took on your website they completed for your classroom. Can you describe what's on that website?

Ms. Anniston: On that website, teacher web.com, which I paid for myself, is in response to some concerns that parents had not knowing what was going on in the classroom. They didn't know what homework the students had to do because some students would not write their homework assignments down. So I post their homework assignment. I also have a study guide; when students did their math fair projects I took pictures and posted them out there; any announcements that the parents need to know - I have that. Students who were going to the Regional Fair are there as well. I have research projects for students that are failing. I am giving students an opportunity for them to recover so they have assignments they need and workbook pages is all out there online.

Researcher: What was the response from the parents?

Ms. Anniston: Most of them are very, very happy because now they know exactly what is going on. If a child loses a paper, I have that assignment on the web where all they have to do is print it out. If something is upcoming like they have two more mini projects, I posted those out there so for those who want to look at something early and get started on it, they can. If they lose the paper, it's still there on the web and they can print it out. There's a home quiz. A lot of parents want to help their children at home so I have a home quiz there at home for them to do. Everything stays up for one week then it comes down at the end of the week and I put up another one.

Researcher: Do all students have computers at home to access this outside of school?

Ms. Aniston: No, some students say they do not have their own personal computers, but I always encourage them that we have an interactive lab here, and we have the library where they can stay after school or come in early. Each teacher on the team has computers in their classroom that they can use during homeroom. No student is penalized for home quiz or anything if they don't have a computer. Every morning if there is something new or different on the web I show it to them in class. I show them the homework in class so if they don't have a computer, or if for some reason they can't get to it that particular night they still know what's on the website every day.

Researcher: Based on your knowledge and experience with using technology what do you recommend teachers do to be successful with technology?

Ms. Anniston: The teacher must be comfortable with using whatever technology he or she is going to use. If they are going to start off using the Interactive White board or the promethean board they must be very familiar with whatever they are going to use for the class. If they are taking students to the Interactive lab they need to be very familiar with helping the students with the computers in the interactive lab. If they are going to use the Mac carts, it's a management part that you have to pass out the lap tops you have to collect them to make sure we have all our laptops to make sure they don't walk out. We have to make sure the students stay in their desks because our desks are so close that if they get up we don't want any of the lap tops to fall. If we had tables in the classroom, or a special place we could go to use them, maybe we could leave the laptops setup; but in this case how it is setup now I have to collect the laptop. So we have to have a lesson short enough to present to students and have time to pass out and collect the laptops. That's where the management comes in.

Researcher: When you get ready to teach surface area, how would you decide what you are going to do to help them learn surface area?

Ms. Anniston: I would have to find what's available on surface area so I know what to assign to the students if they are going to use laptops; but if I'm using surface area with the promethean board it would be more whole class teacher demonstration. If I'm going to give something to each student I would have to have something designed so each student can have an interactive activity already created. I would have to find an interactive activity already created for them to use with surface area. For example, they may have to key in or change the dimensions of a box or a cylinder and they would key those dimensions in and they would see the different sizes or the surface area for different size containers.

Researcher: So is there a process you use to find what's out there?

Ms. Anniston: I go to promethean planet and search for lessons already available. Also, after taking a workshop on Tuesday, now the school system just purchased Net trekker, and I understand that it has flip charts. So I can search Net Trekker to see what flip charts can be used for that particular lesson. Also PBS has different lessons. So I would have to know whatever resources are out there and search to find out what the students are interested in?

Researcher: Do you have the option to customize it to fit what you need for your students?

Ms. Anniston: For net trekker I have not been on it. Now since I know it's there I will start searching to see. For promethean board teachers, once they create them they can publish their lesson on promethean planet. Once they publish them to promethean planet they have their images locked, but I found that you can unlock them and move them around to fit your students.

Researcher: Complete the sentence: I use technology effectively because . . . .

Ms. Anniston: I use technology effectively because we live in a global technological society and in order for our students to compete with others all over the world they need to be technology savvy. They need to know how to compete with everybody, You can't go to the bank; we have these smart phones, the appliances in our home, the car, the television, everything is digital, everything. So if you don't have any kind of computer skills or skills with technology you can hardly survive effectively in our society.

Ms. Bell – Background

Ms. Bell has been teaching at Riverstone Middle School for all of her 8 years as an educator. She has a Master of Arts degree in Teaching and Learning with a specialization in Technology Integration, and is currently working on a Doctorate degree in Teacher Leadership. Ms. Bell is a successful teacher because she demands the best from her students in and out of the classroom and devotes approximately 18 additional hours per week outside of the classroom with her current and former students. They perform well on formative and summative assessments because she works with them beyond regular classroom hours. Approximately 90% of her seventh grade students pass the annual standardized assessment. Ms. Bell enjoys being active in her school. She coaches the cheerleader squad and works with an after school program called the All-Stars. She a big fan of her students, and is supportive of them as often as possible in their community events any day of the week. She is small in stature, often appearing to be one of her students, but has a commanding voice to remind you who she is. Her youthful persona contributes to fostering a healthy teacher-pupil relationship with her seventh graders because she knows how to speak their language. Having a toddler of her own helps her keep up with what children's interests are and what they are exposed to. Ms. Bell's classroom is small and crowded. There is a promethean board in the front of her classroom and an adjacent wall displaying exemplary student work. She has two desk-top computers in the back of her classroom, but only one of them is currently working. She operates her laptop near the promethean board. All of the student desks face the front of the room in five rows. Students follow the daily routine when they enter the classroom. They sharpen pencils, check the board for the daily agenda, and begin working on their sponge activity.

Ms. Bell – Technology Planning

Researcher: Describe your approach to selecting technology.

Ms. Bell: Knowing what is available is number one. If we have something and all students have to be a part of it of course I'm going to have to go through the protocol of making sure the lab and everything is available just because I only have two computers. Then it depends on what I am trying to accomplish and the type of students I have. When structuring my lesson, I aim for multiple representations and differentiation. If we're doing things in class, and let's say the skill is functions, then I want the students to be able to see how that function looks on a graphing calculator. I want them to see the linear relationship when it's actually graphed. So I kind of work backwards to an extent because I'm trying to figure out what they need to know. I'm looking at the overall essential questions and the standards to see what they should master at the end. Then I can kind of determine what would be appropriate and what would be best used to help the students reach that level. It may require that I use the Holt website as a resource for working with small groups because it gives them a lot of skills-based practice and it has some problem solving as well. If students need a remedial lesson, I may choose Brain Pop, which I think is a good tool to use for reinforcement with my students performing on a lower level. Then I also have to consider the gender of my students. Since I have gender classes it's important that I select something that appeals to them. A lot of times what interests my male class does not interest my female class. So when I am designing my lesson the first thing I think about is what's going to click with girls, and what's going to click with boys. Then I search for videos and activities that tie into the lesson I am teaching, but will capture the interest of each class. The next thing I have to think about with my male class is what is interactive. They really like having to do something or move about. So when it comes to them I make sure I have technology they love.

Researcher: Is the technology selected during the time you are creating weekly lesson plans? If not, when?

Ms. Bell: Not really. I know before I teach the lesson what I'm going to do, but most times I pull a lesson from promethean planet or if I want a video I search Discovery Education and preview them in advance to make sure I can connect it to the lesson. It's sort of an ongoing thing.

Researcher: What types of technology do you use?

Ms. Bell: I use calculators, Promethean Board, United Streaming, Movie Maker. That's an engaging piece (Movie Maker) for students to be able to explain concepts just by speaking through characters. Of course with the promethean board I use promethean planet to get some interactive activities. Our textbook publishers have a website with an online tutor for students. I connect it to the promethean board and it helps me monitor the classroom more effectively when we break into small groups.

Researcher: Why do you use technology?

Ms. Bell: It's very engaging for students. It's a break from the monotony. If you do the right activity, it helps the kinesthetic learners who need to get up and move, and it helps me get the attention of the visual learners and keeps them focused. It's motivational for them. Some programs are interactive and give immediate feedback to students as they are working.

Researcher: How do you know when to use technology during your instruction?

Ms. Bell: I use technology throughout the lesson. I know I have a variety of learning styles in my classroom. So I make sure my lesson covers each modality. I always start with technology to get their interest. The promethean board supports my instruction so well that I don't have to lecture too much or repeat myself because the flipcharts save the work and the notes if students need more time to write or review procedures. I

> know that I have to organize my lesson in some kind of order so after I introduce a lesson I check for understanding using a different activity. Once I see that they understand the skill we move into a problem-based activity that usually requires them to work with a partner or a group. Even then technology is still being used because I always keep the work on the board in case they want to refer back to something.

Ms. Bell – Episode One

This is a 7th grade, gender-based classroom (all girls). There were 25 students present. I entered the room just as students were changing classes. The classroom is the last room on the top floor of the building. The classroom contains two white boards on adjacent walls, a teacher desk in the corner of the front of the room, and 28 desks arranged in four rows, all facing the front of the room. In the back of the room is a rectangular table with two older model desk top computers. The walls have print-rich math posters and student quality work on a bulletin board. On the front white board is an agenda for the day. It lists four events – Warm-up, Problem Solving, M&Ms Activity, and Closure.

The standard on the board was coded as M7A1ab, which means the students translated verbal phrases to algebraic expressions. There were two overarching questions guiding the lesson:

1) What strategies can I use to help me understand and represent real situations using expressions and equations?

2) What properties and methods do I need to understand in order to simplify and evaluate expressions?

Ms. Bell's main activity was to have students create equations that represent the total amount of M&Ms. The warm-up activity asked students to perform basic math computations. The next activity was where Ms. Bell spent a little more time checking for depth of understanding with problem solving. On the Promethean board were two problems. The first problem was the following:

Bianca's scoring total for Game 1 was 5a+8b+7c.

Her scoring total for Game 2 was 3a+12b+10c.

What is the difference between her scores in the two games?

a) 2a+4b+10c b) -2a-4b-10c c) 2a-4b-3c d) 2a+4b+3c

Ms. Bell walked around and observed students' work. The teacher used her promethean board as a visual tool, to model concrete examples, and to use a calculator built in the Promethean Board. Based on the common errors she saw as she observed students' answers, Ms. Bell flipped to a new page on the screen and wrote the problem on the board to show the misconception where students subtracted 5a-3a correctly, but subtracted 12b-8b instead of correctly subtracting 8b-12b; and incorrectly subtracted 7c and 10c.

Ms. Bell demonstrated subtracting 7-10 by drawing 7 yellow circles on the board then drawing 3 zero pairs (red and yellow). Ms. Bell used different colors to distinguish positive and negative so that students could see how subtracting 10 from 7 resulted in a negative 3. Ms. Bell placed an 'x' over 10 yellow circles and asked students how many remained. When the students answered three, she knew they understood their error.

Ms. Bell then proceeded to tap on an icon showing a calculator on the screen. The calculator was used to find the answer to the next open-ended question in the warm-up. This calculator was clearly visible to all students. Students gave directions to Ms. Bell as she keyed data in the calculator to guide students on correct procedures.

The second problem was listed as follows:

> Felix's cell phone bill listed four calls. The minutes were listed as .47, 13.2, 4.75, and .92 ¼ . What was the average of Felix's minutes used from his service plan?

Although students did not have calculators at their desk, they calculated their answers manually while another student volunteered to operate the calculator on the promethean board. Satisfied with the class performance, Ms. Bell moved to the next phase of her lesson.

Ms. Bell passed out an activity sheet, a paper towel, and a handful of plain, colorful M&Ms to each student and asked them to work with a partner to complete the assignment. The activity sheet was scanned onto the promethean board so that all students could focus on the directions to complete the activity. Ms. Bell asked students to fill in the blanks with the teacher's M&M candy data. As teacher modeled the lesson she wrote the following data on the board:

Color	Quantity	Equation
brown	6	
yellow	1	
red	3	
green	2	
orange	2	
blue	2	

On the handout were eight questions requiring them to express their quantities algebraically using candies that the teacher had initially, and later with a partner.

The first question:

> I would have to add (or eat) ____ red candies to have the same number of red candies as the teacher. How many red candies do I have?

A student responded if I have only 1 red candy then I would have to add 2 in order to match the three you have on the board. So I think my equation would be x+2=3. The teacher waited for various students to answer the question based on the number of red candies they had to make sure everyone understood what the expectation was. Some students needed to see the problem worked out on the board. Ms. Bell talked them through the question and worked a problem on the board so they could see the process. The next question on the handout asked:

> If I tripled the number of yellow candies I have, I would have ___ more yellow candies than the teacher. How many yellow candies do I have? 3x=1+2.

This problem was confusing until Ms. Bell explained it. Students continued to work through the remaining problems, and Ms. Bell observed and supported the students who had difficulties until lunch time.

Ms. Bell – Episode Two

There were 22 seventh grade male students in this gender-based classroom at 10:00 in the morning. The standard supporting the lesson was M7G2a,b - Transform figures using the coordinate plane. The objective was for students to be able to graph and transform points and geometric shapes on a coordinate plane.

To start the class off Ms. Bell wrote two equations on the board and asked students to solve them. After walking around to check their solutions, she returned to the board and modeled the steps to complete the solution. The two problems Ms. Bell modeled were

1)

$$\begin{array}{rcl} 3x - 4 & = & 14 \\ +4 & & +4 \\ \frac{3x}{3} & = & \frac{18}{3} \\ x & = & 6 \end{array}$$

2)

$$\begin{array}{rcl} 2(f + 7) - 8 & = & 22 \\ 2f + 14 - 8 & = & 22 \\ 2f + 6 & = & 22 \\ -6 & & -6 \\ \frac{2f}{2} & = & \frac{16}{2} \\ f & = & 8 \end{array}$$

After students checked their solutions, Ms. Bell transitioned into the main focus of the lesson. She opened the lesson by using the promethean board to show a video on transformations from a segment pulled from Discovery Math (Discovery Education). The video demonstrated definitions of translations, rotations, and dilations using prehistoric animals in a forest. After the video, Ms. Bell used her flipcharts on the promethean board to review the vocabulary words: translation, dilation, rotation, and reflection on the promethean board and generate a discussion on how they differed. The next page in the flipchart showed a coordinate grid and a question underneath. The problem was stated as:

> The ordered pair of a figure are (2,3), (5,-2). If I move this figure two space to the right, what would your new points be?

Ms. Bell made a chart to show (x,y) ordered pairs and discussed directional movement. Since the figure was moving two spaces to the right, she asked the students which axis would be affected. Since moving to the right is moving along the x-axis, then only the number representing ‘x’ would change.

Original ordered pair	move two spaces right	new ordered pair
(2, 3)	(2 + 2, 3)	(4, 3)
(5, -2)	(5 + 2, -2)	(7, -2)

Ms. Bell readily accessed a coordinate grid with the touch of an icon. The screen was easily visible to all students. Using the stylus pen, Ms. Bell was able to slide the figure in each direction to show the flexibility of translating the figure according to the directions. Ms. Bell then changed the flipchart to show a triangle on a coordinate plane; students came to the board and identified the vertices of the triangle in its original space. Students were asked to reflect the triangle over the y-axis. Another student came to the board and demonstrated the reflection, and wrote the new points of the vertices.

original position of triangle:	A (2,0)	B (5,5)	C (1,4)
reflected over y-axis:	A’ (-2,0)	B’ (-5,5)	C’ (-1,4)

Ms. Bell revealed the next flipchart to where a cube was drawn on a coordinate plane. A student came to the board and identified the vertices of the original location.

A (3,-1) B (1,-3) C (3,-5) D(5,-3)

He was asked if reflected over the x-axis, which quadrant would the figure be in? After much debate the students finally agreed on quadrant 1.

The new vertices of the cube after the reflection would be:

A' (3,1) B' (1,3) C (3,5) D (5, 3)

Ms. Bell stopped because she noticed that students were getting restless. She asked students what is the difference in the two reflections (triangle and cube)? She said "What happened when I reflected over the y-axis in the first problem and the x-axis in the second problem?" She wanted students to see the pattern where the numbers were the same, but the signs changed. A student replied: "When you reflect over the x axis the y number changes and when you reflect over the y axis the x changed to negative." Ms. Bell was pleased and told the students they were 'on point'. To assess the students' understanding of the skill once more, Ms. Bell gave students a figure, cutout from cardstock paper, and a coordinate grid and asked them to trace the figure anywhere on the grid and then translate it:

3 units down and 7 units right

While each student worked, Ms. Bell moved around to each student checking their progress. When they finished, Ms. Bell asked them to turn in their papers. The final assignment of the day required students to identify whether the transformation was a rotation, reflection, or translation. Ms. Bell flipped from screen to screen showing different shapes before and after the transformation. Students had fun because Ms. Bell made a real-world connection for them by showing them that transformations was just like doing the well known dances - 'electric' slide or "cha-cha" slide.

Ms. Bell – Effectiveness of Technology

Researcher: Why did you select United Streaming as part of your lesson?

Ms. Bell: Well, I decided to use United Streaming to go along with the transformation lesson mainly with my all male class because I thought it was engaging. It talked about how transformations were used if they wanted to be a graphic artist or graphic designer. It showed them how this mathematical concept applied to real-world content. It was something I felt they could relate to and so that was the engagement piece to try to pull the students in and allow them to see why this could be important in their lives.

Researcher: What made the use of this technology effective for this lesson (Ep. #1)?

Ms. Bell: Showing students visually how to solve problems is very powerful. Sometimes students get a little confused when working with integers. So in the warm-up I was able to help students see how to check their solutions by drawing pictures. When I need to show students a different way to solve a problem and I don't want to pull out manipulatives, the promethean board helps me accomplish the task a little easier. Then in the meat of today's lesson I was able to display my data so students could see and understand how to think through the problem and construct their equations.

Researcher: What made the use of this technology effective for this lesson (Ep. #2)?

Ms. Bell: I think the engagement piece went well. During the lesson the students were able to actually come up and use the promethean board to manipulate some of the figures we had constructed on the board and I saw a lot of students really motivated by that.

Researcher: For those students who struggled with the concept, what steps did you take to support them?

Ms. Bell: For those students I had one of my top students as a peer tutor and made a group of about 7 students. One of the other students who just mastered the concept and 5 other students worked together the next day. I showed them the hrw.go.com website that goes with our textbook and a video with that. Then while they worked together I worked with other students until everyone was on the same level.

Researcher: What is it that makes using technology effective for you?

Ms. Bell: The good thing about technology is that this is what a lot of the students go home to. This is what grasps their attention. So by being able to bring this into the classroom, it grabs their attention. Integrating different facets of technology each year I see how what I used in my second year as a teacher is obsolete now. Back then, the overhead projector was a fascinating item and students enjoyed it. Now we have a more sophisticated board that's more than just a chalk board. You can change the background colors and draw figures on it and save everything you do.

I know research has been done on what colors do for the brain, and that in itself gives us a different way of looking at what we do. Basically, I want to meet the students where they are. Using technology is more than just entertaining. It allows you to take learning to a higher level.

Researcher: Based on your knowledge and experience with using technology, what do you recommend teachers do to be successful with technology?

Ms. Bell: One thing I was oblivious to under our home page our school system has given us a lot of resources that we can use as far as technology is concerned; so that's a very good start that I would get anyone to go to because every content or grade level can find something specific to meet your needs. As a math teacher I would recommend specifically for math content One Nation. It's always been a very good site for me and my students, and Brain Pop because it helps any level 1 or 2 student. I use those two as my main sources. Then I recommend teachers use Promethean Planet because you don't have to pull a whole lesson together. There are lessons that teachers have already done. All you have to do is just tweak them to fit the needs of your students. Finally, Lesson Planet, which is a site teachers have to subscribe to with a membership fee, but they are lessons teachers have found successful and decided to share. If teachers would take the time to browse the websites they would find some interesting tools, videos, interactive and animated activities to support a quality and engaging lesson to students.

Researcher: Complete the sentence, “I am effective with technology because. . .”

Ms. Bell: I know children are motivated by it. It helps me organize my lesson and make math more interesting.

Mr. Jacobs - Background

Mr. Jacobs is a veteran teacher of seven years at Timberwood Middle School. He has completed his Masters Degree and entertaining thoughts of pursuing advanced degrees. His stature alone is somewhat intimidating. Professionally dressed in a starched long-sleeve shirt and tie, and standing over six feet tall and broad shouldered, Mr. Jacobs appears ready to do business, and expects the same from his eighth grade students. He is a successful teacher at Timberwood because he devotes time to the students, supports the extracurricular activities they participate in, and at least 90% of his students pass the state standardized test each year. His classroom is oddly shaped – similar to a scalene triangle, with the entrance into the classroom being at the vertex of the smallest angle. The spacing in the room, because of its shape, is quite narrow. Desks are arranged in 4 pods of six desks. He does not have computers in his classroom for students to use. He does, however, have a similar setup to the other participants. A promethean board, LCD projector, and laptop are the primary technology tools used in his classroom. He also has a 27 inch television screen mounted from the wall, which is used for a well-structured dismissal process at the end of the day.

Mr. Jacobs – Technology Planning

Researcher: Describe your approach to selecting technology.

Mr. Jacobs: I pull from all sources available. I just look at the technology I feel is best useful for the objective and put them together and make it my own.

Researcher: Is the technology selected during the time you are creating weekly lesson plans?

Mr. Jacobs: I give it some thought, but a lot of times it's the week of or the night before when I go and pull what I want because a lot of the technology is already there, I just add to it.

Researcher: What types of technology do you use?

Mr. Jacobs: The Promethean Board is my primary technology tool I teach from. I use Promethean Planet to get some activities. I use Activotes when I am playing a game with the students. I also use Brain Pop to help them learn math strategies.

Researcher: Why do you use technology?

Mr. Jacobs: Using technology keeps kids interested. Kids get bored real easily. So if you got something to keep them entertained and they're learning at the same time - that helps them out. I also think technology is designed to make your job a little bit easier. It allows you to walk around and observe what's going on in the classroom and give students individual help that you normally wouldn't be able to do without the technology. Technology also helps me gather a lot of data on my students and allows me to hone in on what mistakes kids are making. If I know students incorrectly picked answer choice 'A', then I can find out why they picked 'A' and reteach them so they won't continue to make those mistakes.

Researcher: How do you know when to use technology during your instruction?

Mr. Jacobs: I use technology from the beginning of the class period starting with my sponge to my closing activity. I put everything on the promethean board the night before. I scan my worksheets, and try to place them in sequential order according to the time I am going to use it during class.

Researcher: What do you have to consider when you are preparing a lesson?

Mr. Jacobs: I have to see if it's going to meet the needs of my students. I want to make sure that the technology that I am using is on level – it's not below level. So I don't want to go and pull some technology that will appeal to third and fourth graders and I definitely don't want to pull something that's going to appeal to 10^{th} and 11^{th} graders. I want to keep in the 8^{th} to 9^{th} grade range. I aim high so I can pull them up.

Researcher: How do you use technology with your instruction?

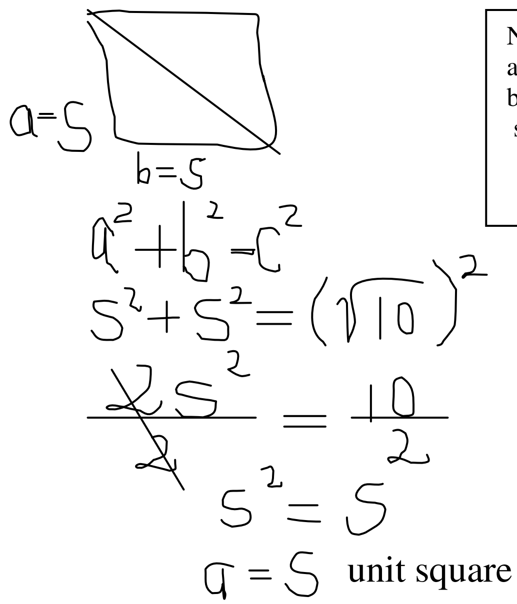
Jacobs: I use it both as a visual aid and as an interactive tool. During the lesson the kids are taking notes and once I present the lesson to them I give them the type of work they need to do. While we are going over the lesson, kids are coming up to the board. They get to play with it. They get to write on it. They get to pull stuff and move things all around so I use it both ways – during the lesson (note taking) and interactively.

Mr. Jacobs – Episode One

On a wall across from his promethean board were three white dry-erase boards. Mr. Jacobs used these boards to hand write his curriculum standards and objective, agenda for the day, and for modeling diagrams and computations if the promethean board was in use. In this episode, Mr. Jacobs worked on teaching students to evaluate expressions. When the objective was accomplished students would be able to evaluate algebraic expressions for a given value, as well as define mathematical terms such as coefficient, constant, variable, and expression. It was 2:20 in the afternoon when Mr. Jacobs' last class of the day entered into the classroom (his school uses block scheduling- 90 minutes per class period). There were 23 students in the classroom. Students were asked to take out homework and start on the sponge activity, which was displayed on the promethean board. As students began working, the lights were dimmed, and the teacher moved around with a clipboard to check for homework and take attendance. On the promethean board were three questions for students to work. The problems were stated as:

1. Find the area of a square which has a diagonal of $\sqrt{10}$.
2. Write the algebraic expression for seven times the quotient of three and a number z.
3. If a triangle has a leg of 5 and a hypotenuse of 9, what is the other leg?

Mr. Jacobs talked the students through problem #1 of the sponge. A student volunteered to go to the promethean board after Mr. Jacobs changed the screen to reflect a figure of a square with a diagonal line. The student solved the problem by writing out his process steps as follows:



Notes:
a = side (s)
b = side (s)
square is colorful and appealing

a = 5 unit square

After reviewing what he wrote the student noticed that maybe you could cut the number of steps in half. Mr. Jacobs gave verbal praise to the student, saying "Very Good", and reiterated the area of a square is equal to side square ($A = s^2$). Students were focused on the board and responded well to the voice of the teacher. After confirming the answers to all three sponge questions, Mr. Jacobs changed the screen to a new flip chart, which showed "Evaluating Expressions" as the title, and the objective beneath – Students will be able to recognize important words for solving expressions. That was his way of transitioning into the focus of the lesson for that day.

The next flip chart showed a screen, full of color and animation. There was a picture of an apple tree with four apples on it. Next to the tree was a dog saying, "What's behind the apples?" On each apple were mathematical terms for students to use in their vocabulary for that instructional unit. The terms were algebraic expression, variable, evaluate, and expression. Mr. Jacobs passed the pen to different students as they volunteered to go to the board and click twice on an apple to show the definition of each word or phrase. Mr. Jacobs asked students to write each definition down as they were revealed on the promethean board.

On his next flip chart above the puppy was a caption cloud saying “Watch out!” The big apple at the top of the screen was labeled ‘variable’. There were smaller apples on the tree labeled ‘g’, ‘b’, and ‘x’. The smaller apples were examples of the term written on the larger apple. On pages that followed, each of the previous terms introduced were written on the large apple and the smaller apples showed examples of the term.

Mr. Jacobs closed the activity with a game called “Give the dogs their bone”. There were three dogs sitting next to their baskets. The baskets were labeled evaluate, expression, and variable. The object of the game was to place the bone in the correct basket. If the bone was in the correct basket, the dog barked. If not, the bone popped back into its original position. The bones were labeled ‘b/3’, ‘4x if x = 9’, and ‘x’. The students eagerly raised their hands to go to the board. One student was emotional because she felt ignored after raising her hand repeatedly. All of the students were engaged in this activity. If they weren’t called upon, they talked with each other about where the bones should be placed.

At the conclusion of the lesson, Mr. Jacobs placed a worksheet on the promethean board. This worksheet had been scanned in on his computer. There were 12 problems for students to work. They were asked to evaluate each expression using the values given. Mr. Jacobs evaluated their answers orally to check for understanding or misconceptions.

Mr. Jacobs – Episode Two

There were 25 students present in this class, which began at half past noon. The objective of the lesson was to identify a function and be able to tell the difference between a relation and a function. At the beginning of the lesson, five problems involving absolute value appeared on the promethean board screen. The students went to the board to work out the solutions while Mr. Jacobs checked for homework.

Mr. Jacobs clicked on an Activ Studio icon from his laptop computer and opened a teacher resource site to retrieve a pre-constructed lesson for the day. On the promethean board screen there appeared a diagram of a mapping of numbers to use in identifying a function. Mr. Jacobs demonstrated a function showing that each element in the first oval (oval **A**) was matched up with only one element in the oval across from it (oval **B)**. Mr. Jacobs then showed a relation that was not a function by matching (drawing a line from one element to another) more than one element from oval B to an element in oval A.

In the second activity, Mr. Jacobs clicked on an icon to display a coordinate plane. He used the grid to demonstrate the vertical line test. He drew several lines – horizontal, vertical, diagonal, u-shaped, v-shaped, m-shaped, and z-shaped. After defining the purpose of the vertical line test was to show that if a vertical line intersected the graph more than once it was not a linear function, Mr. Jacobs asked students to come to the board, draw a vertical line and determine whether the graph was a linear function or not. Students thought there was more to it because it seemed so simple to them.

For the final activity, Mr. Jacobs flipped to a new page in the flip chart, which showed three columns. The first column showed different ways a relation is written. The other two columns had headings of 'relation' and 'function'. The students were instructed to click on the relation in the first column and drag it over to the appropriate column most accurately fitting its description.

Mr. Jacobs – Effectiveness of Technology

Researcher: What made the use of technology effective for this lesson (Ep. #1)?

Mr. Jacobs: The lesson was animated and interactive. Students were engaged because instead of solving a problem and asking the teacher if it's right, the Promethean board allowed the kids to see instantly if they were right or not by the correct placement of the bones.

Researcher: What made the use of technology effective for this lesson (Ep. #2)?

Mr. Jacobs: This lesson was also interactive. It allowed the students to click on a relation and drag that relation to the box that was either a function or not a function. If they drag it to the correct box it would make a sound, but if they drag it to the incorrect box it would go back to the question area.

Researcher: How did you know this would work?

Mr. Jacobs: I kind of figured it would work just because of the kind of students we are teaching now. Most of them have technology. They are using text messaging, cell phones, on social networks; so I took a lesson and made it more like a game and used the computer while I was doing it. I figured kids would be more interested in the lesson versus me doing it on the board or giving them a hand out.

Researcher: What would you do differently next time?

Mr. Jacobs: I would make sure it works ahead of time, because at home it worked fine. However, there was just a little glitch this morning when I was using the promethean board - the lamp went out on me; so the only thing I would do differently is to make sure the technology that I am using is working properly.

Researcher: Based on your knowledge and experience with using technology, what do you recommend teachers do to be successful with technology?

Mr. Jacobs: I think teachers should go through the tutorial session and familiarize themselves with the actual software and program so when its time for them to use it they will know how to and they won't be intimidated or afraid of it. I think they should attend technology workshops, because they show you a lot. Then go home and play with it and try to apply it. Once you become comfortable with it, using it will save you a lot of time. Sometimes a class I'm working with may be 3 or 4 days ahead of my other classes. So I can review the lesson again and go through all the kinks and fix it up so when I get to a class that is moving a little slower I know how to break it down to them. I can't try to teach it to them all at once. I can go through two, three or four slides that I have prepared and break it down that way. That saves time and it helps you move at a slower with students who need more time, and faster with students who catch on fast. Technology really saves you time and makes your class flow a little smoother.

Researcher: Complete the sentence, "I use technology effectively because. . ."

Mr. Jacobs: I am not afraid to use it. I am not afraid to explore and try new things and I know technology is here to make our lives better- make our jobs easier, work smarter and not harder; and technology makes you work smarter. With technology you can do so many more things- it's a lot easier.

Discussion

The data collected through observations, interviews, and lesson plan documents suggest that technology is instrumental in the delivery of instruction to all students, and for effective communication to parents. There were some similarities among the teachers and uniqueness as well. All teachers mainly used their laptops, promethean white boards and LCD projectors as their primary source of hardware with various applications from the Internet such as Brain Pop, United Streaming, Lesson Planet, etc. Each teacher executed math lessons as stated in their plans, but the plans did not capture as much detail as was observed. Their lesson plans merely described in general what kind of skills would be addressed and the activities they planned to do in the warm-up, main focus, and closing segment of the lesson to address those skills. The way they planned to execute each activity was not described in the plans. This is typical because they all tweaked activities up until the day they delivered instruction. Lesson plan documentation served as only one of the tools in the Activity Theory Model; however, planning, itself, has a significant role in the Teacher's Thought Processes Model.

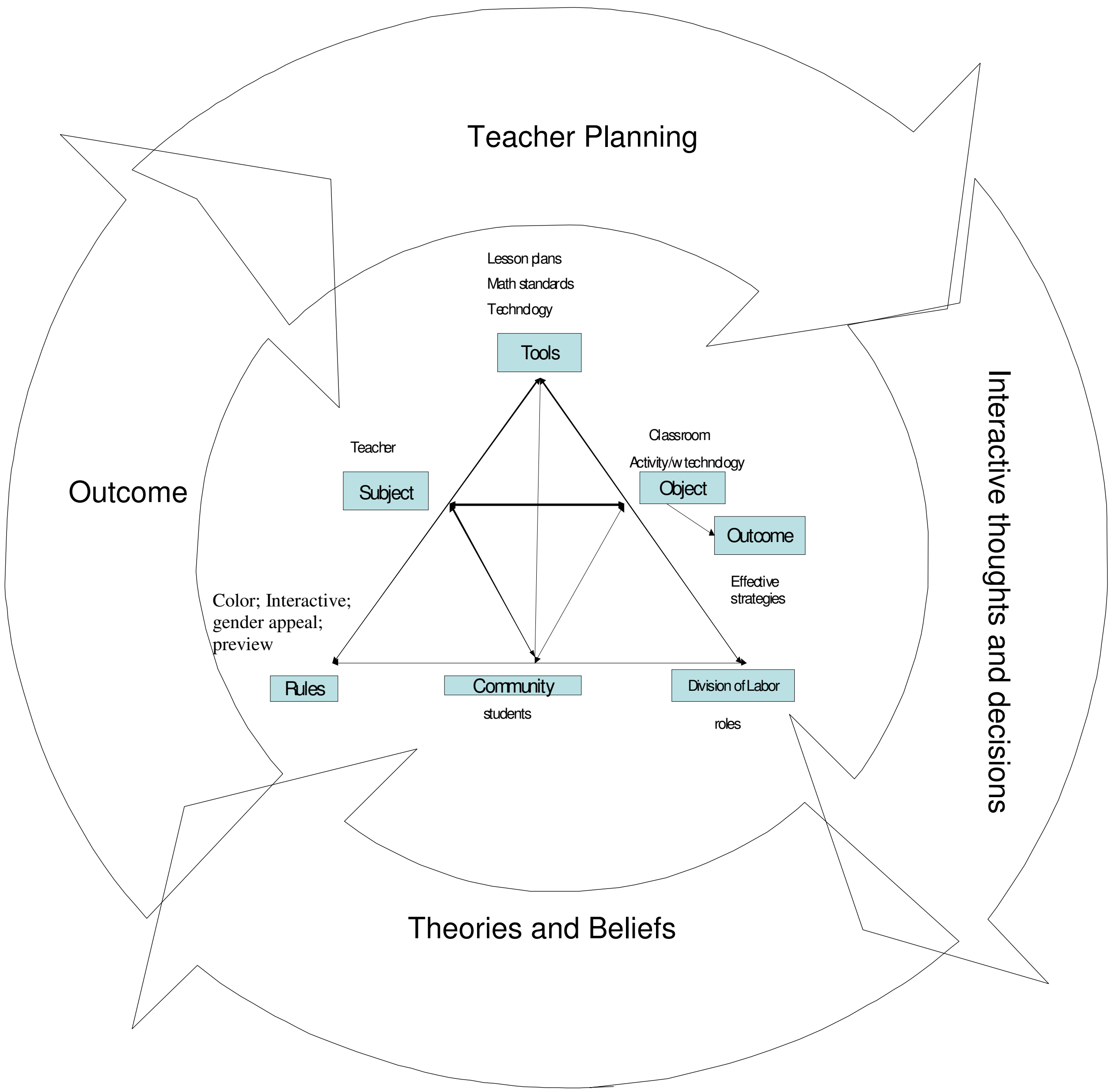


Figure 5. Activity Model and Teachers' Thought Processes Model (combined to show how they worked in conjunction with each other).

According to Kaptelinin and Nardi, (2006) Activity Theory identifies important concepts and helps the researcher understand how certain phenomena take place. Upon collecting and analyzing the data, the components of the path leading to technology strategies became clearer with the use of this model and the Teacher's Thought Processes Model wrapped around it as a supporting structure. Figure 5 shows that within the walls of teacher thinking are those pre and post active thoughts when planning a lesson, those thoughts that occur during the interaction of a lesson, and teacher's theories and beliefs that guide their thoughts and decisions. The original model has only three sections vacillating at each end to represent the reciprocal effect of how teachers' thoughts and decisions are based on their theories and beliefs; and their beliefs are formed from their thoughts and decisions.

My diagram shows a fourth arrow because an outcome or event has to occur to enable teachers to alter their thoughts, decisions, and beliefs. This event may come in the form of students' asking questions, reading other literature, contradicting results, or observing a modeled lesson. No matter how it appears, the event represents an opportunity to recalculate existing thoughts and beliefs. The diagram shows how effective strategies were developed as a result of the teacher (subject) selecting hardware, software, curriculum standards, and lesson plans (tools) to use to develop a classroom activity (object), to address the needs of the students (community). This occurs at the pre-active thinking section of the Thought Process cycle. Teachers' beliefs about technology guide the development of rules used to select and implement a particular hardware/software activity. Those rules include selecting activities that are colorful, animated, interactive, having cultural relevance or gender appeal, and previewing technology to ensure the engagement and learner objective is met. The teachers' role prior to instruction include researcher, task designer, and evaluator as they search and make decisions about the appropriateness of the technology. As they use technology with instruction their roles shift to technician (in case technical issues arise), facilitator and timer to effectively transition from one activity to another, and evaluator to determine the success of the activities on student learning. These roles guide teachers' interactive and post active thoughts. The teacher in the post active thinking phase assesses the attributes fostering the success of the technology integration then decides what modifications need to be made, if any, when considering other learners and other skills within the content. The outcome represents the measure of student learning as a result of teaching with technology, and, therefore an effective strategy.

Another significant discovery with the data collected in this study is how close these teachers' practices are in alignment with Kent's plan to successful teaching with technology. Other practices of teachers who use technology successfully cited in the literature review were also recognizable in the data and will be discussed further as we approach the answer to the questions guiding this research.

How Teachers Used Technology Effectively

Kent's fifth step in teaching with technology is to implement effectively (2008). In this step he defines how teachers should use the tools they have to deliver quality instruction to students. He begins with teachers understanding the hardware, software, and website options available to them. Each teacher reported spending hours outside of the classroom searching for appropriate technology to use with their lessons. Even as late as the night before implementing the lesson, teachers wanted to ensure the activities they had selected accomplished the desired goal and addressed the needs of all students. Although Mr. Jacobs encountered a problem with the lamp on his promethean board, his knowledge of the equipment allowed him to diagnose and repair the problem so that his lesson continued with minimal delay.

He then recommends that teachers add variety by using multiple resources to keep students' interest and limit the use of one technology taking a break to prevent off-task behavior. The daily agenda for each classroom observed permitted the teachers to transition from one activity to another within a reasonable length of time. By doing so, each teacher projected a different lesson using their ready-made flipcharts, requiring students' full attention. Ms. Bell, in her second episode, transitioned from a video to different screens showing coordinate grids for drawing and identifying transformations. Mr. Jacobs also used variety when he began with a sponge activity, then moving to a colorful interactive series of activities for students to learn about relations and functions. Ms. Anniston used variety even during her assessment. Rather than prompting students to change from one activity to the next, Ms. Anniston allowed the students to work at their own pace. Students transitioned from one assessment to another, documented their errors, and then proceeded to visit her teacher-created web-site for further activities. These teachers know what their students need and seemed very much aware of how to structure the class time for middle school students.

Encourage student involvement (Kent, 2008). Teachers should not hesitate to allow students to interact with the technology. As Friedman (2007) and NCTM (2000) both noted classrooms should provide experiences with technology in order for students to be able to compete in a global society. Therefore, when teachers design lessons, they should build in opportunities for students to interact with the technology tools used with the lesson. All of the teachers in this study were comfortable with having students use the promethean board and laptops. They are all aware that these students are digital natives and prefer to use technology as often as possible. Ms. Bell mentioned how using technology reduces the amount of lecturing she used to do in the classroom. Mr. Jacobs' purposely selects technology that kids can play with, because it enhances student learning.

Also in step five Kent promotes the use of technology with assessments. Ms. Anniston was observed using a laptop cart in her classroom to administer an assessment. She wanted to check for students' mathematical understanding of factors, multiples, prime factorization, greatest common factor, and least common multiples. However, she wanted more than just checking if a problem was right or wrong. Ms. Anniston, wanted the test to be randomized to prevent students being able to share answers, and she wanted them to get immediate feedback and address their misconceptions. Using technology allowed her to accomplish her goal and determine her next steps for remediation earlier than she could have with a paper-pencil test.

Finally, Kent (2008) suggests teachers have fun with technology and make it fun for students also. The survey conducted by Draude and Brace in 1999 also found that when technology is utilized effectively, learning is more interesting and fun. In each of the classrooms observed, I noticed not only were the students engaged, but everyone had fun, including the teacher (and me, the researcher, who almost forgot I was collecting data). The time and energy these teachers exert to prepare for student learning increase student effort and motivate the teacher to continue searching and designing more lessons with technology.

Comparison of Teacher Practices

Revisiting the nationwide study of teachers who were considered experienced and accomplished at integrating technology in the classroom (Sheingold & Hadley, 1990), I compare the results of their teacher practices to the data collected in this study, keeping in mind that their study included grades 4 through 12 and all content areas. The first finding in the study by Sheingold & Hadley (1990) discovered that teachers devote considerable time and effort to teaching with technology. Their teachers were comfortable with technology, devote their personal time to learning how to use it, and take advantage of the training and support available to them. In this study all of the teachers were comfortable with using technology daily, and Ms. Anniston admitted that she had attended a workshop recently on another software tool that she was going to go home and explore how to use it so that she could add it to her list of resources.

The nationwide study also found that the key incentive for teaching with computers is to allow student to use the tools for their own learning. Sheingold & Hadley (1990) reported from the survey that teachers allowed students to create their own products each week. Students were given project-based learning activities and produced newspaper articles for a school newspaper, video discs, budgets, computer programs to display constellations, and other projects allowing students to connect to the world beyond the classroom. Although I did not observe any project-based activities, one teacher stated that she requires students to use technology with their projects. As noted earlier, the teachers in the nationwide study that reported project-based activities were not mathematics teachers; therefore, the use of technology is expected to be different. I did not specifically inquire about teacher incentive for using technology. Nonetheless, the teachers in this study promoted students interaction with technology in each lesson.

Teachers in the Sheingold & Hadley study used the computer as a multipurpose tool (1990). They described teachers' multi-use as having a large software repertoire, and using computers for demonstrations, drill and practice, and remediation. Each teacher in this study modeled the same, although the word 'large' should be quantified.

Becoming a teacher who uses technology effectively is not an easy task. Sheingold & Hadley (1990) report that it takes five to six years to accomplish effective technology practices. The teachers in this study were not asked how long it took to develop at this level. They all admit, however, that it is an ongoing process.

Successful Teachers

As the researcher, I wanted to verify these participants who were referred by administrative staff members as successful teachers who use technology effectively. I compiled the evidence in Table 7 below upon transcribing their interviews and observing them in the classroom. There were some noticeable characteristics supporting their description of being successful teachers according to my definition for this study, and the characteristics described by Ladson-Billings (1995), Gehrke ((2005), and Brown (2003). Each row describes the action observed or information provided in the interview to validate the characteristic of successful teaching.

Table 7

Evidence of Successful Teacher Characteristics

Successful Teacher Characteristics	Ms. Anniston	Ms. Bell	Mr. Jacobs
Culturally-Relevant Pedagogy	Passionate about teaching; supports students with skill deficiencies	Compared transformation to doing the cha-cha slide; uses student language	Bonded with students by talking about the kind of dog they have.
Sets high expectations	80% passing rate on high-stakes tests	90% passing rate on high-stakes tests	90% passing rate on high-stakes tests
Meaningful activities	Identifying fractional parts of a ruler; Number & Operations	Writing algebraic expressions; Transformations	Relations and functions; Algebraic expressions
Engages all students	Each student was assigned their own laptop.	Students worked in pairs with M&Ms.	Oral student participation in all activities.
Flexibility	Multiple activities; facilitator; authoritarian	Multiple activities; facilitator	Multiple activities; facilitator
Warm and caring	Answered student questions	Moved around the classroom to each group; attentive; supports extracurricular activities	Visible; sensitive to student needs; supports extracurricular activities
Assertive	Very confident and in control	Very confident and in control	Very confident and in control

Each participant clearly distinguished themselves as successful teachers. The one attribute that stood out in each classroom I visited was the level of student engagement. These teachers knew the right technology to select to motivate students to learn. The classrooms were lively and students immediately and eagerly responded to teacher directives. TPAK played a role in their learning also, because without the teacher's style of presentation (pedagogy) and content knowledge, it may not have been as effective.

Technology Strategies

The focus questions for understanding and indentifying the technology strategies are: (1) How do successful urban middle grades mathematics teachers, who use technology effectively, describe their teaching practices? (2) What strategies do teachers use when integrating technology effectively in the classroom? After manually coding the interviews and observations, five major themes emerged from the data that teachers found essential for technology to be effective in the classroom. These five themes are: Preparation, Engagement, Assessment, Communication, and Evaluation. Within these five themes are the strategies that make using technology effective.

Preparation

- Know what kind of technology is available to you.
- Review your standards and objectives and search for activities that support them.
- Consider your audience when deciding what is appropriate.
- Preview the technology prior to using in the classroom.

As OTA (1995) required, these teachers selected appropriate technology to suit the standards taught in their classroom. Before using technology, Mr. Jacobs stated he had to just sit down and play around with it to become comfortable with it. Ms. Anniston and Ms. Bell stated that through collaboration with others they learned what was available in their school and district, and through various trainings and practice they gradually increased the use of technology in their classroom. In order to prepare a lesson using technology answers to three questions are required. The teacher must know who the audience is, what the students' needs are, and what the goal to be accomplished is. Ms. Bell's classes are gender based. Therefore, she begins by identifying whether she is searching for activities to use with girls or boys. She also considers what these students need in order to increase the likelihood of mastery. Ms. Bell knew that boys and girls have different interests. Therefore, her choice of activities has to appeal to them. She can select different activities that have real-world applications, and accomplish the same objective with both genders. Ms. Bell understands that boys are more energetic than girls. So on the day she teaches her male class, Ms. Bell uses lessons that motivate them to get out of their seat and manipulate objects. Ms. Bell then asks the question, "What is the goal for today?" In addition to knowing what the curriculum standard is that she has to teach, she also decides on whether she is introducing, remediating, or reviewing a lesson. Ms. Bell has different resources she prefers to use for students who need more time to learn math skills. Each of the teachers examines the goal they seek to accomplish before selecting an activity. However, once she determines their readiness, Ms. Anniston creates assessments for her students to take online that save time in scoring and providing feedback. Once the teacher has identified what the goal is, who they are preparing a lesson for, and where these students are on learning spectrum, they proceed with their search for the kind of technology that would be of greatest benefit to the students.

Also emergent from the data collected were teachers who previewed the technology before using in the classroom. Even though the activities are previewed sometimes mishaps still occur as with Mr. Jacobs. He thought he was well prepared only to find out when he turned on the machine his bulb was out and needed to be replaced. While he knew how to use the software, he neglected to check the hardware early enough to eliminate down time.

Sometimes there just isn't any way of knowing if the hardware has any glitches. When Ms. Anniston was distributing laptops to students, some of the laptops were not programmed properly. Apparently she had already contacted technology support and requested a technician be on standby in her room in case problems surfaced. Although she was not aware of any problems, she was proactive and prepared for the moment something happened to limit the amount of disruption in accomplishing her goal for the day.

Engagement

- To promote engagement of all learners, select a variety of activities that are colorful, animated, and artistic to capture students' attention and require action to engage student thinking.
- Use equity when allowing students to interact with technology.

In each classroom I observed, students were focused and highly engaged in their assignments. Each teacher uses technology to keep students' interested in doing mathematics. Each teacher made comments about how technology plays a significant role in student engagement.

Ms. Anniston stated that activities are selected that are colorful. "I learned long time ago that colors do things to some students. It gets them excited because just plain white I feel like is boring to some students."

Ms. Bell: Now we have a more sophisticated board that's more than just a chalk board. You can change the background colors and draw figures on it and save everything you do. I know research has been done on what colors do for the brain, and that in itself gives us a different way of looking at what we do. Basically, I want to meet the students where they are. Using technology is more than just entertaining. It allows you to take learning to a higher level.

Mr. Jacobs: "They get to play with it. They get to write on it. They get to pull stuff and move things all around. . ."

Ms. Anniston: I vary the problems according to the level of difficulty. Some students move at a more rapid pace than others, so I have to find something that challenges everyone where they are.

Ms. Bell: If you do the right activity, it helps the kinesthetic learners who need to get up and move, and it helps me get the attention of the visual learners and keeps them focused. It's motivational for them. Some programs are interactive and give immediate feedback to students as they are working.

When students see something they enjoy it is an exciting time for them. Teachers should take precaution and ensure that all students have an opportunity to interact with technology if possible. In one of the observations with Mr. Jacobs, a student kept raising her hand to answer a question. She first volunteered to uncover the apples on the tree; but the teacher didn't acknowledge her. She also wanted to go to the board and manipulate the bones in the bowl.

Again the teacher overlooked her hand. She gave up in dismay and slouched in her chair saying "You don't ever call on me. I'm just raising my hand and you keep ignoring me!." If students are seated in small groups, the teacher could set a rule to hear from a spokesperson from each group. That would enable more students to respond as they are chosen by their group members.

Assessment

- Use technology to create assessments, and to score and provide feedback to students.

Ms. Anniston used technology to assess students' understanding of the unit previously taught over the previous weeks. She created assessments using a random generator so that students would not cheat. She also used a website that would score students' responses and give them immediate feedback. Both teacher and student benefit by using electronic assessments because it saves time. It eliminates students having to wait for Ms. Anniston to manually score papers. Instead, students can use that time reviewing their mistakes and thinking of questions to ask the teacher to avoid repeating the same mistake. Ms. Anniston benefits also by obtaining instant class reports that identify strengths and weaknesses so that she can prepare for remediation if necessary.

Communication

- Create a classroom web page for parents and students to keep them connected.

In this age of technology, everyone wants knowledge as quickly as possible. Parents have schedules that oftentimes conflict with the school's operating hours. Although they may not be present physically, they still want accessibility to the teacher and the classroom. Ms. Anniston made it possible for her parents to be involved and feel a part of the school community. Her creative efforts satisfy her parent's needs and students as well.

Evaluation

- After each activity conduct your personal evaluation of the technology used.

Teachers must keep in mind the overall goal of the lesson. By the time class ends, a teacher knows whether the technology used was appropriate or not. Teachers should reflect and ask themselves how the lesson could be improved. Collaborating with others makes this process much easier. Although an activity appears to have relevance to the skill taught, it may not accomplish the overall goal. Sometimes it means a change in hardware or software. Sometimes it's a matter of adjusting to meet the needs of the students. Each teacher mentioned how the flipcharts enable them to save information and tweak as needed for different classes. Sometimes a problem may be too complex for one class and just right for another. In this case the teacher should adjust the problem so that it is manageable for other students. Ultimately, students want to experience success, which presents a challenge for teachers to create opportunities to make it happen for them.

Summary

This study was designed to identify those strategies successful teachers of middle grades mathematics in urban schools use. While many studies have determined the need for technology in the classroom, or studied the various kinds of technology available for teachers to use in schools, little is known about the process of selecting appropriate technology to use in order for teachers to be effective. The participants in this study are competent mathematics teachers who understand their students and also understand the significance of using technology in the classroom. They understand how our world continues to advance progressively with structured technologies in every industry that exists, and that classrooms must change with the times. These teachers have experienced the classroom transformation from chalkboards to overhead projectors to LCD projectors. Along with this transformation they have shifted from skill and drill handouts to hands-on/interactive lessons. Consequently, the reason why they use technology is an obvious one - they are comfortable with using technology; they keep abreast of the technology trends in our society and they are aware of the needs of their students. Digital natives are able to identify with the skills and concepts better, and teachers know that technology is required in order to be effective. This study, therefore, illuminated their practice of selecting the appropriate technology for teaching mathematics to middle school students.

Chapter 5

Conclusion and Implications

The goal of this study was to inform the audience of the strategies successful urban middle school mathematics teachers employ when using technology in the classroom. Presenting their strategies added depth to my understanding of the process. Mathematics teachers may use different tools, but how they select those tools are very similar. The process will require teachers to spend most of their time in the preparation phase due to searching for the right tools to fit the students' needs. To my surprise, age does not necessarily affect the use of technology. I mentioned earlier that younger teachers are more willing to use technology than more experienced ones. Ms. Anniston, with 23 years of experience, enjoys using technology, and is a trailblazer in her school when it comes to using technology.

Some of the steps in Kent's list were employed by the participants in this study. They all planned in advanced and knew how to use the technology they had selected. They used a variety of resources. Ms. Bell used interactive flipcharts and videos all in the same class period. Mr. Jacobs used interactive flipcharts and guided practice problems, and Ms. Anniston used flipcharts, laptops, and a variety of websites in her classroom to increase student engagement. Ms. Aniston was also observed utilizing assessments with technology.

Limitations of the study

There are several limitations in this study. First, the time spent observing technology used in the classroom limited the amount of variations of technology included in this study. If I had invested more than four months observing these participants the results may be enriched with a broader use of technology tools and activities, and more closely resemble the nationwide survey by Sheingold & Hadley and have more similarities with Kent.

Another limitation was the sampling method used. Purposeful sampling was used for this study, and therefore, limited to only one of the five school teams in the school district where I am employed. This district has a large population of low-economic, African American students. This district also employs more African American teachers than other ethnicities. If the sampling were more widespread from different school teams or other school districts there would be greater diversity, and the results would yield a broader use of technologies because of teachers' backgrounds, exposure, and interests. This study primarily included promethean whiteboard, laptop hardware, video streaming, and internet software. Had this study been expanded over the metropolitan area, other hardware and software tools may have been observed to strengthen the findings and provide more strategies for selecting and using technology effectively. After all, there are e-textbooks, digital equipment, and podcasting just to name a few technologies that exist, but were not included in the data collection for this study.

Obtaining lesson plans from participants was also a limitation. Participants were unable to provide lesson plans prior to my classroom observations. They knew the standards they would be teaching because it was included in their curriculum guide. However, because my observations were scheduled early in the week, they were not available until the day I arrived for the observation. Therefore, lessons could not be discussed in depth until after implementation. One might suggest that the use of technology was insincere, and that my presence affected the selection of technology used because the participant knew in advance that I was coming to observe and wanted to 'put on a show'. Nonetheless, I keep in mind that these teachers were recommended because of their past reputation as a successful teacher who uses technology effectively in the classroom. They were familiar with the technology and the process they used to select the technology. My focus was not on the technology used, but rather, the process by which they selected and used the technology in their classroom. Each participant was able to explain their process, which supported the findings of this research.

Implications and Recommendations

Research should continue as newer technologies evolve in the future and serve as a conduit for teaching and learning. With each new technology innovation, its performance should be tested in a classroom setting, and compared to other technologies as well as other subject areas regarding the benefits it provides to the teachers and the students, and the way it strengthens teaching and enhances learning.

While this research observed the classroom practices of teachers who use technology effectively in the classroom, only four of the six benefits of technology integration from the research Cradler (1995) were connected to data analyzed in this study. Increased performance, opportunities for interactivity, and effectiveness with multiple technologies were observable benefits. This study could extend beyond technology strategies to evaluate the other three benefits, improvement in attitude and confidence, increase in preparation of students for most careers and vocations, and particularly, improvement in problem-solving skills. A comparative study could guide the research to investigate perceptions and attitudes of reluctant math students who took classes from a successful teacher who uses technology to increase mathematical learning. Students' beliefs about the type of technology used and the way information is presented in terms of its level of entertainment may be useful to educators who believe technology is the primary tool for maximum learning outcomes. The findings from this kind of study would also inform software developers and publishers of e-books on how do illustrate information that would be appealing to students. Another angle researchers could explore is to examine whether using technology contributes to closing the achievement gap among subgroups. If research proves technology to be effective with reluctant math students and contributes to closing the achievement gap, every inner city school district would allocate more funds toward the purchase of technology, and teachers would collaborate more to share success stories and their experiences with various technologies.

Finally, it is the presumption of the researcher that these teachers would be successful without the use of technology. The research focused primarily on teachers and how they select and use technology with their instruction. The study did not measure the impact that technology had on learning or the students' thought process. Therefore, a future study could compare and contrast the student's behavior and thought processes with the use of technology in a regular classroom setting.

Closing

With new software developments occurring so rapidly, tools that may have worked in the past will lack the necessary appeal needed to keep students' interests later on. As teachers continue to use technology effectively in the classroom, keeping abreast of new tools and products is essential to motivating students and advancing student performance. This implies administrators must provide appropriate training for teachers as new developments occur. Whether the district conducts their own training, or sends employees to technology conferences, they must be willing to support teachers in giving their best to students and reduce the amount of time it takes for teachers to become proficient users of technology. Funding to acquire 'state-of-the-art' technology tools and qualified staffing are also needed if the use of technology continues to be a powerful tool that opens the classroom up to a world of endless possibilities.

This research was intended to inform educators in administrative capacity, professional learning, and subject area leaders within schools who value the use of technology in the classroom to help them make wise decisions about their technology plan. Upon realizing the determination of the participants in this study to utilize technology as a means to prepare students for the real world and to motivate all students to learn, administrators are recommended to evaluate the technology in their school and district. An audit team can assess the amount of technology currently being used and by which teachers. Then they can determine what the needs are and create a workable plan to invest in technology and support all teachers in the process of integrating technology in their classroom. The benefit of engaging all students in the learning process makes it worthwhile.

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APPENDIXES

APPENDIX A

Georgia State University
Department of Middle and Secondary Education and Instructional Technology
Informed Consent

Title: Strategies for Using Technology in the Urban Middle Grades Mathematics Classroom

Principal Investigator: Christine Thomas, Principal Investigator
Tammie Scott, Student Principal Investigator

I. Purpose: The purpose of this study is to investigate how successful teachers in urban middle schools effectively use technology as a tool for advancing mathematics achievement in the classroom.

You are invited to participate in this research study because you have been identified as a veteran mathematics teacher who consistently uses technology in your classroom activities. A total of five participants will be recruited for this study. Participation will require approximately 8 hours of your time over the next four months.

II. Procedures: If you decide to participate, you will undergo a series of six individual interviews. You will be interviewed by the student principal investigator at the beginning of the study, before and after two separate lessons are executed, and at the conclusion of the study. These interviews will be audio taped at a time convenient for you in your classroom after normal school hours. Each interview will last approximately one hour. In addition to the interviews, the student investigator will observe two classroom lessons where you are integrating technology. These observations may also be audio recorded. The student investigator will also take written notes on what is observed in your classroom. There will be no interaction between the student investigator and the student at any time; nor will any interaction take place between the student investigator and the teacher during the observation. The student investigator will discuss the observation in a post interview on the same day the observation occurs after school hours.

III. Risks: In this study, you will not have any more risks than you would in a normal day or life.

IV. Benefits: Participation in this study may not benefit you personally. Overall, we hope to gain information about your methods of integrating technology in the classroom, and use them to benefit those teachers who are not currently using technology, as well as benefit professional development with recommendations for teacher support and training needs.

V. <u>Voluntary Participation and Withdrawal:</u> Participation in research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. <u>Confidentiality:</u> We will keep your records private to the extent allowed by law. Dr. Christine Thomas and Tammie Scott will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP) and/or the Food and Drug Administration (FDA), and the sponsor). We will use a code name rather than your name on study records. The information you provide will be stored at the student investigator's home in a locked file cabinet. The codes to identify the research participants in this study will be stored separately from the data to protect your privacy. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally. The audio tapes will be stored and kept private in the student investigator's home in a locked file cabinet for one year after the last date of data collection. All information, documents, tapes, and files will be shredded and destroyed one year after all data has been collected for the study.

VII. Contact Persons: Contact Christine Thomas at 404-413-8065 or via email at cthomas11@gsu.edu, or Tammie Scott at 404-202-7678 or via email at tcravens@atlanta.k12.ga.us if you have questions about this study. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or via email at svogtner1@gsu.edu.

VIII. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research and be audio recorded, please sign below.

____ ________________

Participant Date

____ ________________

Principal Investigator or Researcher Obtaining Consent

APPENDIX B

Interview Questions

1. How long have you been teaching?
2. How often do you use technology in the classroom?
3. Is technology easily accessible in your school? What types of technology are available?
4. Why do you use technology?
5. What types of technology do you use?
6. What type of benefit is there in using technology?
7. Is there a specific time more appropriate than others when technology is more effective?
8. How do you select the technology you use? Describe your approach to selecting technology.
9. Is the technology selected during the time you are creating weekly lesson plans? If not, when?
10. What do you do with the technology during your instruction?
11. How do you determine what the expectation should be when using technology?
12. Does the technology always accomplish what you want it to? If not, what are your next steps?

13. How do you know when to use technology in your lesson? How long do you use the technology? Is there ever a time limit on the use of technology? Why, or why not?
14. What are the most important criteria to consider when deciding to use technology?
15. How do you know the technology you use is effective?