THE EFFECT OF WIRELESS MOBILE CART ACCESS

ON THE LEVEL OF IN-SERVICE TEACHERS'

TECHNOLOGY IMPLEMENTATION

IN A SOUTHWESTERN

URBAN SCHOOL DISTRICT

By

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ABSTRACT

K-12 school districts in the United States have spent billions of dollars annually to purchase and maintain educational technology giving teachers nationwide more technology to enhance teaching and learning than ever before. However, many teachers are not maximizing the use of that technology in classroom instruction.

The Southwestern urban school district that was the site for this study spent $4 million dollars on the acquisition and deployment of wireless mobile laptop carts in 2006 and in 2007 to provide increased access to internet-connected computers for students. Eighty-three in-service teachers participated in taking an online survey (LoTiQ) developed by Moersch (1995). The data gathered addressed seven research questions that investigated four variables.

Although 90 percent of teachers reported having access to wireless mobile carts, 60 percent said they never used them. Teachers had the requisite technology proficiency and instructional practices to perform at higher LoTi Levels, yet 55 percent of teachers were clustered at the lowest technology implementation levels. Seventy-one percent of barriers to non-use identified by teachers were systemic in nature, and were more useful for explaining non-use than access or proficiency. A majority of teachers identified time to learn, practice, and plan as the greatest barrier to technology use in the classroom.

CHAPTER I

Introduction

Since Congress passed the No Child Left Behind Act of 2001 (NCLB) as a reauthorization of the Elementary and Secondary Education Act in 2002, states, districts, and schools in the United States have struggled to apply the essential NCLB technology mandates to local technology implementation initiatives (Learning Point Associates, 2007). Over one percent or approximately three billion dollars of all Federal Government expenditures for Education is spent on educational technology (Shewey, 1998). *NCLB Title II, Part D – Enhancing Education through Technology* appropriated one billion each year for five years through 2007 to carry out subparts one and two which provides for state and local technology grants, and supports national technology activities.

The NCLB national technology activities included a mandate for the U. S. Department of Education to publish a national long-range technology plan that would describe how the Secretary would promote higher student achievement through the integration of advanced and emerging technologies into curricula and instruction, increase access to technology for teaching and learning in high poverty schools, and assist in the implementation of state systematic reform strategies (No Child Left Behind Act of 2001; 2002). Initially the U.S. Department of Education's Office of Educational Technology (OET), focused on improving student access to computers and the Internet.

In 1994 only 35 percent of U.S. K-12 public schools had access to the Internet, and in 1998 there was only a 12 to 1 computer to student access. The progress in Internet-connected computer access can be clearly seen. In 2007, 100 percent of U.S. K-12 public schools were connected to the Internet, and had at least a 3.8 to 1 computer to student ratio (ies National Center for Education Statistics, 2006; Trotter, 2007; U.S. Department of Education Office of Educational Technology, 2004). While the OET mandates are still concerned with student access to current technology, there is a growing concern about the fidelity of implementation for educational technology. Fidelity of implementation involves having a comprehensive set of guidelines that target essential components like principal support for software implementation, having a clear plan for integrating software use with core curriculum, ongoing training, and on-site technical support. Successful technology implementation can no longer be measured solely by percent of Internet-connected schools and student to computer ratios (Lipper & Sagehorn, 2007).

OET guidelines require a technology plan for all schools receiving education rate (E-rate) funding that subsidizes the cost of public schools' telecommunications services, and in most states regardless of E-rate eligibility. As a result, there are a growing number of clearly articulated school district technology plans that align themselves with the U.S. Department of Education *National Education Technology Plan of 2004*. These district technology plans have allocations for millions of dollars to purchase and maintain educational technology, and include the OET fidelity of implementation guidelines.

The Southwestern urban school district that was the site for this study was among the aforementioned districts that have a clearly articulated technology plan. The implementation of this plan resulted in 100 percent access to Internet-connected computers, and a student to computer ratio that is comparable to the national average. In 2001, metropolitan voters in the area that encompasses this school district approved a historic bond issue and tax initiative that will generate 692 million dollars by 2009 to improve school infrastructure in both urban and suburban school districts. The allotment for the Southwestern urban school district was $530 million with $52 million allocated for computer technology. In addition 57 percent of the schools in the district are eligible for Federal Title I Funds which generates thousands in additional money for technology purchases. As a result of this funding, several significant technology projects were completed.

In 2002, all teachers were given laptops, and every two classrooms were provided with presentation stations including TV, stand, and scanner. In 2005, all classrooms were wired for Internet access bringing both wired and wireless broadband connectivity to individual classrooms for the first time. In December 2006 every building received two wireless mobile laptop carts supplied with 12 laptop computers. Each cart has a 24 computer capacity. The wireless mobile laptop computer deployment was in addition to an ongoing Request for Technology (RFT) initiative that put hundreds of desktop computers in the district schools for student access. These computers were primarily installed in computer labs rather than in classrooms. The wireless mobile laptop cart is designed to travel to each classroom. This mobility innovation takes the computer lab to the classroom.

In spite of large technology expenditures, increased access, and nearly universal use of computers by children ages 5-17 (85 percent)(ies National Center For Education Statistics, 2006) many teachers are not using that technology for enriching classroom instruction. Since 1994, the National Center for Education Statistics (NCES) has documented the large increase in access to computers and the Internet in the nation's public elementary and secondary schools. The increase in access is up from 34 percent in 1994 to 100 percent in 2007. These increases have led to a need on a national level to understand the extent and types of teacher use of computers and the Internet, as well as teachers' perceptions of their own preparedness to use these tools in their classes. (ies National Center For Education Statistics, 2006; U.S. Department of Education Office of Educational Technology, 2004). This information is critical for the U.S. Department of Education Office of Educational Technology in determining national technology policy direction and in guiding technology expenditures.

According to a 2006 national survey sponsored by CDW Government, Inc. (CDW-G), and conducted by Quality Education Data (QED), 82 percent of teachers strongly agreed that computers were valuable for engaging students in the learning process, but only 37 percent used computer technology on a daily basis (CDW Government Inc., 2006). An understanding of the discrepancy between teacher's beliefs about technology use and their actual practice will help to advance efforts toward greater technology use in classroom instruction. In addition, this understanding will help to address the accountability issues relating to technology acquisitions.

Problem Statement

In keeping with national trends, the large technology expenditures to provide universal computer access for teachers and students in the Southwestern urban school district created a need on a district level to understand the types and extent of teacher use of computers and the Internet, as well as teachers' perceptions of their own preparedness to use computers in their classes.

Approximately $3,463,200 dollars were spent on the Wireless Mobile Cart technology, with an additional $1,509,600 dollars planned for the purchase of 12 additional laptops per cart. In spite of the expenditure of millions of dollars for wireless mobile cart technology, many teachers were not using that technology in classroom instruction. The district did not have information on the types or extent of teacher use, the effectiveness of teacher use, or the reasons for teacher non-use of the wireless mobile cart. As a result, district technology leaders could not determine the most effective means for encouraging teacher adoption of the wireless mobile cart which would maximize the district's investment. In addition, technology leaders could not provide researched based data related to the effectiveness of technology instructional interventions that are a reporting requirement in connection with the expenditures of federal and state funds.

Purpose of the Study

This study investigated the effect of wireless mobile cart access on in-service teachers' level of technology implementation in a Pre-Kindergarten to 12th Grade Southwestern urban school district. McAdoo (2005) measured implementation levels for this district following a deployment of teacher laptops using the Levels of Technology Implementation Questionnaire (LoTiQ) developed by Moersch (2001).

In similar fashion, this study investigated teachers' level of technology implementation with the LoTiQ following the introduction of a particular technology. The prior study measured teachers' LoTi levels after the introduction of technology for teacher use. In contrast this study measured teachers' LoTi levels after the introduction of technology for student use. This research will add to the body of literature to explain teachers' levels of technology integration in classroom instruction and teacher perceived barriers to the use of technology.

Theoretical Framework

Rogers (1995, 2003) Diffusion of Innovations Theory (DOI) is the theoretical framework for this study. Rogers (1995) formalized the Diffusion of Innovations Theory. DOI is a meta-theory that organizes several closely related theoretical perspectives that are part of the overall concept of diffusion. These are: (1) the Rate of Adoption Theory, (2) the Individual Innovativeness Theory, (3) the Innovation-Decision Process Theory, and (4) the Theory of Perceived Innovation Attributes.

Research Questions

There are many factors that have the potential to impact the level of teacher technology implementation. These factors include age, gender, years of teaching experience, levels taught, teacher technology efficacy, teacher technology proficiency, teacher instructional practices, teacher education level, teacher/student technology access, as well as enabling school structures.

This study investigated teacher technology proficiency/efficacy (PCU), teacher current instructional practice (CIP), and teacher/student technology access (WMCA). These are the factors that have the greatest potential for change through technology acquisition and professional development (Goddard, Hoy and Wolfolk-Hoy, 2000). The questions that guided this research are:

1. What is the level of teacher and student access to wireless mobile cart technology (WMCA)?
2. What is the current level of technology implementation (C-LoTi) in the district?
3. Does wireless mobile cart access relate to the current level of technology implementation(C-LoTi) in the district?
4. What is the level of teacher technology proficiency/efficacy (PCU)?
5. Does the level of teacher technology proficiency/efficacy (PCU) relate to the current level of technology implementation (C-LoTi) in the district?
6. Is teacher-centered or learner-centered practice the more predominant Current Instructional Practice (CIP)?

7. Is there a relationship between Current Instructional Practice (CIP) and the current level of technology implementation (C-Loti) in the district?

Overview of the Study

This quantitative study used a cross-sectional survey design method that was administered online through the National Business Education Alliance (NBEA) secure website. The purpose of cross-sectional survey design is to describe the attitudes, opinions, preferences, demographics, practices, and procedures at one point in time of a selected sample that can be generalized to a population. This method is appropriate for investigating a variety of educational problems and issues, and was appropriate for this study (Gay & Arasian, 2000).

The Levels of Technology Implementation Questionnaire (LoTiQ) a 50-item survey instrument was used, along with ten custom demographic questions developed by the researcher. The LoTiQ was developed by Moersch (2001), and permission to use the instrument in this study was granted following application and payment to the NBEA.

The target population was certified teachers employed by a Pre-Kindergarten to 12th grade urban school district located in a U.S. Southwestern city. The data from the LoTiQ were stored on a secured server, and once downloaded from the server were kept on a computer that was independent of network access. This preserved participant confidentiality. The survey allowed participants to create a user ID and password known only to the participant which preserved anonymity. The relationship between variables, research questions, and survey items are outlined in Table 1.

Table 1

Relationship Between Variables, Research Questions, and LoTiQ Survey Items.

Variable Name	Research Question	Items on LoTiQ	Method of Data Analysis
Independent Variable #1: Wireless Mobile Cart Access (WMCA)	Research Question #1: What is the level of teacher/student access to wireless mobile cart technology in the district? Research Question # 3: Does wireless mobile cart access relate to C-LoTi in the district?	Additional Demographic Questions: 7, 8, 9	RQ# 1: descriptive statistics (i.e. percentages & frequencies) RQ # 3: Stepwise Multiple Regression
Dependent Variable: Current Level of Technology Implementation (C-LoTi)	Research Question #2: What is C-LoTi in the district?	LoTiQ Questions: 1-5,7-12, 14, 16, 17,19, 21-25, 27-31, 33-40, & 42-48	RQ #2: descriptive statistics (i.e. percentages & frequencies)
Independent Variable #2: Teacher Technology Proficiency/Efficacy (PCU)	Research Question#4: What is the level of PCU? Research Question#5: Does the level of teacher PCU relate to C-LoTi?	LoTiQ Questions: 13,15, 18, 26, and 49 Additional Demographic Question: 10	RQ #4: descriptive statistics (i.e. percentages & frequencies) RQ #5: Stepwise Multiple Regression
Independent Variable #3: Teacher Current Instructional Practice (CIP)	Research Question #6: Is teacher-centered or learner-centered practice the more predominant CIP? Research Question #7: Is there a relationship between CIP and C-LoTi in the district?	LoTi Questions 6, 20, 32, 41, and 50	RQ #6: descriptive statistics (i.e. percentages & frequencies) RQ #7: Stepwise Multiple Regression

Definitions

1. Core Academic – The essential subjects in K-12 education as outlined by the No Child Left Behind Act of 2001. These subjects are: English, Reading or Language Arts, Mathematics, Science, Foreign Languages, Civics and government, Economics, arts, History and Geography (No Child Left Behind Act of 2001, 2002)
2. Current Instructional Practice (CIP) – the specific teaching practice of a teacher as identified by the section of the LoTiQ instrument that indicates whether a teacher's instructional delivery method is either teacher-centered versus student centered.
3. Diffusion – the process in which an innovation is communicated through certain channels over time among the members of a social system. Diffusion is a special type of communication in which the messages are about a new idea. Diffusion is a kind of social change (Rogers, 2003).
4. Digital divide – refers to the gap between individuals, households, businesses and geographic areas of different socio-economic levels with regard to both their opportunities to access information and communication technologies, and to their use of the Internet for a wide variety of activities (Trotter, 2007).
5. Education Rate (E-Rate) – Federal government funding authorized by Congress in the Telecommunications Act of 1996 that subsidizes the cost of public schools' telecommunications services (Trotter, 2007).

6. Enabling School Structure – based on Technology Standards for School Administrators (TSSA), the degree to which principals, administrators, and school district specialists are leaders in modeling, sharing, and supporting effective use of technology for teaching and learning (Collaborative for Technology Standards for School Administrators (TSSA Collaborative), 2006).
7. Fidelity of implementation – a comprehensive set of guidelines for implementing the use of educational technology that includes principal support, goals for use with core curriculum, ongoing training, and on-site technical support (Lipper & Sagehorn, 2007).
8. Teacher Technology Proficiency/Efficacy (PCU) – the degree to which a teacher is confident about performing technology integration tasks, and the level of expertise with computer technology as identified by the section of the LoTiQ instrument that measures personal computer use (PCU).
9. Technocentrism – the approach to solving problems by means of advanced science and technology (O'Riordan, 1981)
10. Technology – technology has a variety of meanings both broad and narrow. For this study technology will be used to mean wireless mobile cart computer technology (Moersch, 1995; McAdoo, 2005).
11. Technology Implementation (LoTi) – the level of technology use in classroom instruction as identified by the LoTiQ instrument that places a teacher in one of seven categories ranging from Nonuse to Refinement.

12. Technology Integration – the specific level (Level 4) of technology use within the LoTi framework identified as the target level or lowest level that is considered sufficient to demonstrate *authentic* use of technology.
13. Wireless Mobile Cart Access (WMCA) – the frequency that teachers and students are able to secure the use of the Wireless Mobile Cart for use in the classroom.

Limitations and Assumptions of the Study

A basic assumption of this study that can be seen as a limitation is its technocentric paradigm. Technocentrism was originally used by O'Riordan (1981) to discuss two major orientations of environmental politics. Technocentrism is at one end of a continuum, and ecocentrism is at the other end. Technocentrism embraces advanced science and technology as an approach to solving problems (O'Riordan, 1981).

Pro-innovation bias is also one of the limitations of this study. Pro-innovation bias assumes that an innovation should be diffused to and adopted by all members of a social system, that it should be diffused rapidly, and that the innovation should not be either re-invented or rejected. Pro-innovation bias is one of the major criticisms of diffusion studies (Rogers, 2003). Technology implementation was identified in this study as the ultimate goal, and implementation at the highest levels of the LoTi framework as measured by the LoTiQ instrument was implied as the optimal situation for teaching and learning. The LoTi framework is aligned with DOI theory.

Another limitation is tied to the nature of self-report survey research. Results were compiled from a self-administered online survey that can only be generalized to the population of a single school district. Although social desirability (i.e., purposeful distortion of truth in order to present oneself in a positive light) may occur, it is assumed that participants will understand the questions and respond truthfully (Fisher, 1993). Stoltzfus (2005) conducted an extensive study of the LoTiQ that determined the survey has validity as a unidimensional measure of teachers' levels of technology implementation.

Quantitative descriptive research is also limited because it does not answer *should* questions. Inherent in the quantitative research design is the inability to capture the full richness of the research site and participants' complexity (Gay & Arasian, 2000 p. 26).

Significance of the Study

Billions of dollars nationwide are spent on educational technology each year giving teachers greater access to technology for the classroom than ever before. However, many teachers are not using that technology to enrich and enhance teaching and learning. Since the majority of funds for technology purchases are publicly derived, there is a growing trend to assess teachers' technology use in the classroom to satisfy the stringent measures for accountability and evaluation of federally funded programs, and formula-based competitive grants that require research-based evidence of effectiveness of instructional interventions (Moersch, 2002). School administrators and those who are responsible for incorporating NCLB technology mandates into local technology implementation initiatives will benefit from the results of this study by having a better understanding of the levels of teacher technology implementation.

The level of technology implementation (LoTi) offers a framework for quantifying and discussing authentic technology use in the classroom (Moersch, 1995). The understanding of teacher technology implementation levels will also allow those responsible for digital leadership to become more effective in managing technology initiatives by providing a credible way to measure the impact of specific technologies for classroom use.

This descriptive study will add to the growing body of LoTi related literature. There have been numerous research projects using the LoTiQ since 2000. The LoTi framework has been used in a variety of studies to explain teacher technology implementation. In separate studies Schechter (2000) and McAdoo (2005) found that the majority of teachers they surveyed operated at the lowest levels of technology implementation (Levels 0-2).The results of this study using the LoTiQ identified the rate, pattern, and extent of technology implementation in a given school district, and provided a way to determine the propensity of this teacher population to adopt and assimilate a particular technology (Fichman, 1999; Rogers, 1995).

Teachers in K-12 education have unprecedented access to technology yet many teachers are not using that technology in classroom instruction.

This study investigated key factors that influence the level of teacher technology implementation in a Southwestern urban school district. It is believed that administrators, technology directors, and other stakeholders want successful technology implementation as outlined by the OET fidelity of implementation guidelines.

This research is presented in five chapters, with references and appendices. Chapter I contains the introduction and definition of terms which gives the background information for the study. This background information establishes the context for the problem statement, purpose, and significance of the study that are given. In addition, assumptions and limitations are presented, and research design and methods are discussed.

Chapter II outlines the literature related to the funding for educational technology, access to technology, technology implementation and student achievement, barriers to implementation of educational technology, the framework for measuring technology use (Moersch, 2001), and Rogers (1995) Diffusion of Innovations theory as it relates to teacher technology implementation. Research design, methods, and procedures are fully developed in Chapter III. Findings and data analysis are thoroughly outlined in Chapter IV. Finally, Chapter V contains summary and conclusions along with the implications for future research.

CHAPTER II – REVIEW OF LITERATURE

Introduction

> Technology integration is when a teacher thinks about and uses technology to accomplish some teaching and learning goal. It is integrated when the thought and action occur seamlessly. It is integrated when the learners do not need extensive direction or training with each new tool or technology. It is integrated when the form of the technology is not prespecified and the teacher does not describe him or herself as a certain type of technology teacher (e.g. a Web instructor or an expert at movie digitalization) (Bonk, 2001)

Billions in educational technology expenditures nationwide has provided teachers with unprecedented access, yet many teachers are not using that technology in classroom instruction. Since the majority of funds for educational technology purchases come from public sources such as the Federal Title II Part D – Enhancing Education Through Technology program that is a part of NCLB, and state and local tax initiatives, school districts struggle to measure up to the accountability standards that are connected to these funding sources (Learning Point Associates, 2007). Federal and state programs, as well as formula-based competitive grants require research-based evidence that demonstrates the effectiveness of technology driven instructional interventions. As a result, there is a growing trend to assess teachers' technology use in the classroom (Moersch, 2002). Successful technology implementation can no longer be measured solely by percent of Internet-connected schools and student to computer ratios but must address the growing concerns about the fidelity of implementation for educational technology.

Fidelity of implementation involves understanding the environmental variables that are critical to the success of instructional intervention, and recognizing that a technology instructional intervention is not just a stand-alone event, but is part of a comprehensive set of guidelines that need to be put in place. Technology fidelity of implementation involves having a clear rationale for using software with the school's core curriculum, ongoing training, and on-site technical support. (Lipper & Sagehorn, 2007).   Fidelity of implementation concerns stem directly from the key concepts and goals of NCLB Title II, Part D. The main goals of NCLB Title II, Part D are:

- To improve student achievement through the use of technology in elementary and secondary schools.
- To assist every student in crossing the digital divide by ensuring that every student is technologically literate by the time the student finishes eighth grade, regardless of the student's race, ethnicity, gender, family income, geographic location, or disability.

- To encourage the effective integration of technology resources and systems with teacher training and curriculum development to establish research-based instructional methods that can be widely implemented as best practices by state education agencies and local education agencies (*No Child Left Behind Act of 2001, 2002*).

NCLB gives very specific guidelines for professional development of all educational staff so that administrators, pre-service and in-service teachers, paraprofessionals, and library media specialists can effectively integrate technology into their jobs. Effective integration includes using technology efficiently, infusing it into the curriculum, and supporting technology literacy skill development. Professional development must be ongoing, and is required to establish the use of scientifically based research on instructional methods (Learning Point Associates, 2007; *No Child Left Behind Act of 2001, 2002*).

In addition, NCLB requires the provision of technology literacy for all students, including students with disabilities, racial and ethnic minorities, low-income students, migrant populations, and English language learners. The U.S. Department of Education in collaboration with the International Society for Technology in Education (ISTE) developed technology literacy standards that outline the proficiencies students must achieve by the eighth grade (Learning Point Associates, 2007; *No Child Left Behind Act of 2001, 2002*). The National Educational Technology Standards for Students (NETS-S) was revised, and the new standards were released by ISTE in June 2007. NETS-S has six standards with four performance indicators under each standard. Students are expected to achieve the following competencies:

- Standard 1: Creativity and Innovation – students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Standard 2: Communication and Collaboration – students use digital media and environments to communicate and work collaboratively, including at a distance.
- Standard 3: Research and Information Fluency – students apply digital tools to gather, evaluate, and use information.
- Standard 4: Critical Thinking, Problem Solving, and Decision Making – students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
- Standard 5: Digital Citizenship – students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
- Standard 6: Technology Operations and Concepts – students demonstrate a sound understanding of technology concepts, systems, and operations (International Society for Technology in Education, 2007).

Equitable technology access, fidelity of technology implementation, and universal technology literacy are the lofty mandates of NCLB Title II, Part D.

These mandates have been the impetus behind K-12 schools nationwide making huge technology purchases, and aggressively building technology infrastructure to increase access.

Access and Funding of Educational Technology

One billion dollars each year from 2002 to 2007 was appropriated to enact NCLB Title II, Part D, subparts one and two – Enhancing Education Through Technology which provided technology grants for states and local school districts nationwide. These technology grants supported state and local technology initiatives that built technology infrastructure to provide technology access for teachers, administrators, students and their parents (*No Child Left Behind Act of 2001, 2002*).

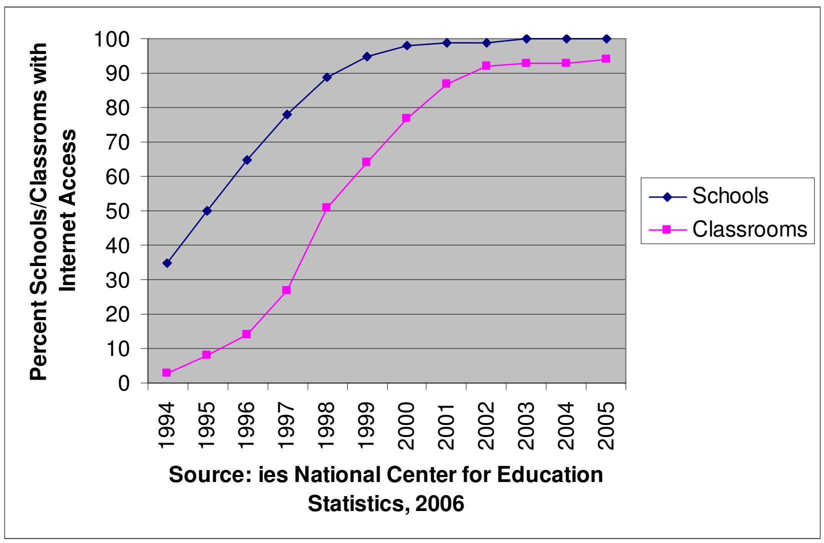
The Telecommunications Act of 1996 provided for an education rate (E-rate) program that subsidized the cost of public schools' telecommunications services and Internet access that amounted to two billion dollars annually. In addition, many state and local governments followed the lead of the Federal Government and established grant programs that supplied millions of dollars to help school districts with the purchase of classroom computers, and invested in statewide networks that supplied web based educational content to teachers. Companies large and small in business and industry as well as many private charitable foundations have provided millions of dollars to fund technology purchases in America's public schools (Trotter, 2007).

Internet access in public schools across the country increased dramatically between 1994 and 2005 due largely to the federal E-rate program.

Internet access in public schools went from 35 percent in 1994 to 100 percent in 2005. Internet access in classrooms also increased along the same lines. In 1994 only three percent of classrooms in the U.S. had Internet-connected computers but by 2005 94 percent of classrooms were wired (National Center for Education Statistics, 2006).

Figure 1

Internet Access in U.S. Public Schools and Classrooms 1994-2005



In spite of what appeared to be universal access, when the National Center for Education Statistics results were broken down by a school's grade span, size and student demographics there were small gaps in classroom access. There were also differences between urban and non urban classrooms. Eighty-eight percent of classrooms in inner-city schools had access compared to 95 to 98 percent of non-urban classrooms. In addition, although all schools and most classrooms had computers with Internet access not every student had equal access to them. Equality of student access was measured by the ratio of students to computers. Student to computer ratios have only been tracked since 1998. The national ratio of students to computers steadily decreased from 12 to 1 in 1998 to 3.8 to 1 in 2007. There were variances in the ratio of students to computers from state to state with a low ratio of 2 to 1 in Maine and South Dakota and a high ratio of 5 to 1 in Utah, California, and Mississippi. (National Center for Education Statistics, 2006; U.S. Department of Education Office of Educational Technology, 2004; Vinograd-Bausell, 2008).

Over the last 10 years, policymakers on almost every level gave priority to increasing technology access in schools. As a result, the dominant theme for research was measuring and tracking access. This researcher located two organizations that tracked national K-12 technology trends for a decade.

The first organization was Edweek.org utilizing information from the National Assessment of Educational Progress sponsored by the federal government, and Market Data Retrieval (MDR) which was a research company based in Shelton, Connecticut. Edweek.org analyzed technology from Federal and State Government policy perspective. For two years Education Week's Journal *Technology Counts* issued a report that graded the states on their leadership in three core areas of technology policy and practice: access, use, and capacity.

For the 2008 state report cards, Indicators related to educational technology access were derived from a 2005-2006 public school survey conducted by Market Data Retrieval, and from background questionnaires administered as part of the 2007 National Assessment of Educational Progress.

Information on technology use and capacity was obtained from a 2007 nationwide survey of state technology officials conducted by the Editorial Projects in Education (EPE) Research Center.

The *Technology Counts* report assigned grades to each of the 50 states and the District of Columbia. Points were awarded and a grade calculated for performance on the components in each of the three core areas (access, use, and capacity), and an overall technology performance grade was computed as an average of the scores in the three core areas. Table 2 outlines the components that were graded in the three core areas and gives the grading scale (Vinograd Bausell, 2008).

Table 2

State Technology Report Card Components.

Technology Counts State Report Card Core Areas	
Access to Technology (State=C) Percent of students with: *Access to computers (4th grade)* *Access to computers (8th grade)* Number of students per: *Instructional computer* *High-speed Internet-connected computer*	Capacity to Use Technology (State=A-) State includes technology in its: *Teacher standards* *Administrator standards* *Initial teacher-license requirements* *Teacher-recertification requirements* *Administrator-recertification requirements*
Use of Technology (State=B-) *Student standards include technology* *State tests students on technology* *State has established a virtual school* *State offers computer-based assessments*	Overall Technology Score (State = B-) *Access to technology* *Use of technology* *Capacity to use technology* Total score = (average of the 3 categories)
Grading Curve: 93-100 = A 83-86 = B 73-76 = C 63-66 = D 90-92 = A- 80-82 = B- 70-72 = C- 60-62 = D- 87-89 = B+ 77-79 = C+ 67-69 = D+ 0-59 = F	

The 2008 *Technology Counts* overall grade for the nation was C-plus. West Virginia earned the only A, and Georgia and South Dakota earned an A-minus. The majority of the states received grades from C-minus to C-plus. Nevada, Oregon, and Rhode Island earned D's, while the District of Columbia ranked last with a D-minus. The state that was the site for this study received an overall grade of B-minus, which was an average of the C, A-minus, and B-minus for access, use, and capacity respectively that the state earned on each component (Education Week, 2008).

The second organization that tracked K-12 technology use trends was CDW Government, Inc (CDW-G). CDW-G used Quality Education Data Company (QED) to survey teachers nationally. One key finding from the CDW-G (2006) Teachers Talk Tech Survey indicated that teachers viewed computers as an increasingly essential job tool for not only administrative functions and communications with others, but also as a teaching tool for students. Teachers had an understanding of the broad use of technology and how appropriate technology could improve core curricula skills. Another key finding was that teachers cited access to computers as the number one obstacle to fully integrating computers into the curriculum. This finding seemed to contradict the numbers indicating that access to computers in U.S. classrooms was nearly universal (CDW Government Inc., 2006).

Trotter (2007) stated that America's policy leaders can take a bow. He pointed to the widespread availability of digital tools for learning in classrooms today as the reason to applaud. The vast majority of schools and classrooms nationwide had multiple, multimedia Internet-connected computers with high-quality software that allow students to use search engines to research term papers, and create class projects using multimedia tools. For the most part, the priority national policy goal of getting technology into schools has been accomplished. Nevertheless, it may be too soon to celebrate. In spite of the unprecedented access to Internet-connected computer technology many teachers and students are not using that technology to enhance teaching and learning. In addition, there is little evidence to confirm that near universal technology access has translated into significant improvements in student achievement.

Technology Implementation and Student Achievement

The intention of public policy to improve student achievement for the disadvantaged as articulated in NCLB (2001) may very well be on target. Few would argue against providing equal access for all to technology resources in the nation's public schools. There is strong evidence that NCLB (2001) has been the catalyst for driving changes that avoided the further development of the "digital divide" (Trotter, 2007). The numbers in the report from the 2006 National Center for Education Statistics (NCES) clearly show that in 2003 no major differences existed in school technology access based on family income, race/ethnicity, gender, household language, or parent educational attainment. However, there were huge differences in computer technology access at home based on these same characteristics.

Without an NCLB mandated technology intervention, almost half of the children in the U.S. ages 5 to 17 years old in households with incomes below $35,000 annually would not have technology access either in school or at home. Likewise households where parents have less than a high school diploma, almost 60 percent would not have Internet access, and in households speaking Spanish only, almost 70 percent would be without computers and Internet access either at school or at home. The following table shows Internet use by children and adolescents ages 5 to 17 years old based on the aforementioned user characteristics.

Table 3

Computer and Internet Use by Children and Adolescents: 2003

User Characteristics	Number of Children (1,000)	Percent using computers at school	Percent using computers at home
Family Income:			
Under $20,000	16,459	81.3	51.7
20,000 to 34, 999	8,615	81.9	55.7
35,000 to 49,999	6,993	85.9	72.2
50,000 to 74,999	9,053	86.0	80.5
75,000 or more	12,441	88.5	89.3
Race/ethnicity:			
White alone, non-Hispanic	32,279	86.6	79.6
Black alone, non-Hispanic	8,048	82.6	47.2
Hispanic	9,503	79.7	48.3
Other	3,731	82.1	71.4
Gender:			
Male	27,422	84.2	68.0
Female	26,139	84.7	69.3
Household Language:			
Spanish only	2,680	75.3	33.6
Not Spanish only	50,881	84.9	70.5
Parent educational attainment:			
Less than high school	10,001	77.9	43.7
credential	15,270	84.1	61.4
High school credential	14,384	86.8	75.4
Some college	9,410	86.9	86.5
Bachelor's degree	4,495	87.6	89.5
Graduate education			
Source: U.S. National Center for Education Statistics, CPS October (Education) Supplement, October 2003, special tabulation.			

It appears that federal government, state, and local policymakers' decision to act now and ask questions later was the right choice. Nevertheless, seven years after NCLB reauthorization the question is being asked: What influence does nearly universal computer access and lower student to computer ratios have on student achievement? This question is being asked not only by those who have challenged or opposed computer placement in the classroom for the last decade (Alliance for Childhood, 2000; Cuban, 2001; Oppenheimer, 2003) but it is also being asked by the very policymakers and administrators who have pushed to establish technology access (Renzulli, 2008; Trotter, 2007; U.S. Department of Education Office of Educational Technology, 2004).

Anecdotal evidence that include success stories as well as horror stories related to technology implementation initiatives are abundant. However research on technology implementation and its effect on student achievement are not as abundant, and the studies reviewed for this research were inconclusive.

The National Education Technology (NET) Plan - *Toward a New Golden Age in American Education: How the Internet, the Law and Today's Students are Revolutionizing Expectations* (2004) published by the U.S. Department of Education made the case for accountability very clear. This plan identified that while hundreds of billions of dollars had been spent on education over the 20 years prior to 2004, reading scores remained flat in that same 20 year period. However, there was the belief that NCLB initiatives had begun to reverse the trend. The plan also stated that while the development of educational technology was thriving, its application in our schools was not, and that the promise of technology in education has not been realized. Nevertheless, (*NET*) *Plan* was overwhelmingly positive. Its name set the tone for this report. The NET Plan reiterated that virtually every public school had access to the Internet, yet in most schools, it was business as usual. It also identified that the “digital divide” was no longer the gap between rich and poor schools but was the widening gap between Internet-savvy students and their schools (U.S. Department of Education Office of Educational Technology, 2004).

The NET Plan presented technology implementation success stories from schools across the nation. These schools were held up as technology leaders with reproducible reform models that other schools could follow. The Chugach School District (CSD) in south central Alaska received the Malcolm Baldridge National Quality Award for performance excellence in education. This award was given after Chugach used technology to improve student learning to the degree that reading scores rose from the 28th percentile in 1995 to the 71st percentile in 1999, math scores increased from 54th to 78th, and language arts scores improved from 26th to 72nd as measured by the California Achievement Test. In addition, only one student in 26 years had graduated from college, but with the dramatic improvements, in 2004 fourteen CSD graduates were attending post-secondary institutions (U.S. Department of Education Office of Educational Technology, 2004).

Another success story cited by NET Plan was the Peabody Elementary School in St. Louis. Peabody served nearly 100 percent Title I students. The principal put the enhancing Missouri’s Instructional Networked Teaching Strategies (eMINTS) in place. eMINTS provided 200 hours of professional development, coaching and technical support for teachers to use multimedia tools to promote critical thinking and problem-solving techniques. A technology-rich environment allowed teachers to personalize instruction and track student progress on a daily basis (U.S. Department of Education Office of Educational Technology, 2004).

In 2001, only seven percent of Peabody third graders could read at grade level. The following year the number improved to 25 percent, and in 2003, 80 percent of third graders were reading on grade level. The school also had similar results in math, science, and social studies. This stunning example of improvement earned an additional $8.4 million grant from the U.S. Department of Education for the eMINTS program (U.S. Department of Education Office of Educational Technology, 2004). NET Plan gave at least eleven other examples of technology implementation success in schools and districts from California to Florida.

The NET Plan report concluded with recommendations for seven major action steps:

> 1. Strengthen Leadership; 2. Consider Innovative Budgeting; 3. Improve Teacher Training; 4. Support E-Learning and Virtual Schools; 5. Encourage Broadband Access; 6. Move Toward Digital Content; and 7. Integrate Data Systems.

The NET Plan's (2004) optimism was summed up in one of the concluding statements that is found on page 46 of the report: "With the benefits of technology, highly trained teachers, a motivated student body and the requirements of No Child Left Behind, the next ten years could see a spectacular rise in achievement – and may usher in a new golden age for American education" (U.S. Department of Education Office of Educational Technology, 2004).

Not only were there numerous documented improvement success stories in support of the wisdom of NCLB mandated nationwide technology initiatives, there were also some documented unimproved stories that seem to challenge this wisdom. *The Wall Street Journal* and *The New York Times* carried articles in 2006 and in 2007 respectively that identified serious problems associated with initiatives providing one-to-one computing access in an elementary school in California, and a high school in New York. A parent of a sixth grader in the California elementary school withdrew her child from the laptop program because her daughter's standardized writing test scores fell. The mother complained that her daughter spent class time playing games, sending instant messages to friends, and trying to access social network sites (Vascellaro, 2006).

The New York Times reported that an entire school district just outside of Syracuse decided to phase out laptops in the fall of 2007. The reason for the decision was that students were finding a way to exchange answers on tests, download pornography, and hack into local businesses. When security was tightened, a 10th grader not only found a way around it but also posted step-by-step instructions on the web for other students. In addition, too many leased laptops broke down each month, and the network would freeze during study hall every day. The district concluded that after seven years there was no evidence that this one-to-one computing access had any impact on student achievement (Hu, 2007)

NCLB (2001) has a student achievement reporting requirement for states and school districts or Local Education Agencies (LEA) in order to monitor the progress toward accomplishing the 10-year school improvement goals that were set forth in Title I and II, and that must be accomplished by 2014. Each state has a requirement to outline a long term strategy for student achievement (No Child Left Behind Act of 2001, 2002).

As a result, most states created some type of Academic Performance Index (API) to measure district and individual school performance. The API is a numeric score that ranges from 0 to 1500 and is based on a variety of educational indicators whose components are used to meet the reporting requirements in the NCLB. Reading and math scores from state achievement tests are components along with attendance rates, and graduation rates. Subgroups of students are segmented and evaluated in the API reports by ethnicity, disability, migrant status, economic status, whether they are English Language Learners (ELL), and whether they are a part of the regular education student population. To evaluate the progress of an individual school or school district, the API results are evaluated in comparison to state established yearly benchmarks. The performance benchmarks increase each year to the year 2014 at which time all schools should achieve API of 1500.

A school or district must meet or exceed the annual performance targets in order to receive a determination of making Adequate Yearly Progress (AYP).

A school district that fails to make AYP for two consecutive years based on the same subject across all grade spans is designated as in “Need of Improvement”. Individual schools that fail to make AYP for two consecutive years based on the same subject is designated as in “Need of Improvement” (State Department of Education, 2003-2004; 2004-2005; 2005-2006; 2006-2007). Districts and schools that remain on the “Need of Improvement” list for four or more years are subject to interventions from state and federal education departments, and run the risk of being managed completely by state or federal agencies.

The school district that was the site for this study met AYP for the first time since NCLB reporting began in the 2003-2004. This district was also identified as in “Need of Improvement”. The AYP milestone was achieved in the 2006-2007 school year. The district moved from having only 54 percent of schools make AYP in 2003-2004 to 71 percent of schools making AYP in 2007. In 2003-2004 there were 29 schools that were identified as in “Need of Improvement”, but in 2006-2007 this decreased to 15. In addition, 7 of the 15 schools in “Need of Improvement” met AYP for the 2006-2007 school year, however schools must make AYP for two consecutive years before they are removed from the State Department of Education’s Designated Improvement list. Likewise a school district must make AYP for two consecutive years before it is removed from the State Department of Education’s Designated Improvement list.

Table 4 outlines the school district report card results from the 2003-2004 school year to the 2006-2007 school year.

Table 4

School District API Report Card 2003-2004 to 2006-2007

Year	2003-2004	2004-2005	2005-2006	2006-2007
District Total API	869	928	1006	1062
State Total API Average	1086	1159	1180	1252
Did District Make AYP?	NO	NO	NO	YES
District on "Needs of Improvement"?	YES	YES	YES	YES
Number of Schools on "Needs of Improvement"	29	24	14	15

Some of the studies that investigate the correlation between technology implementation and student achievement conclude that technology implementation has a positive effect on student achievement (Caruthers, 2008; Diem, 2000; Lord, 2000). However, the majority of these studies to date conclude that although technology implementation has a positive impact on student attitudes and engagement, it has a neutral effect or no impact on student achievement (Cuban, 2001; Oppenheimer, 2003b; Renzulli, 2008; Waxman, Lin, & Michko, 2003).

Rogers (1995) Diffusion of Innovations Theory and the Rate of Technology Adoption

Research on the diffusion and assimilation of technology innovations abound. More than sixty years of diffusion research confirms that diffusion of innovations is a virtually universal process of social change. The regularities or patterns of diffusions have been found across cultures, innovations, and the people who adopt the innovations (Rogers, 2003).

Rogers (1995) formalized the Diffusion of Innovations Theory (DOI). DOI is a meta-theory that organizes several closely related theoretical perspectives that are part of the overall concept of diffusion. These are: (1) the Rate of Adoption Theory, (2) the Individual Innovativeness Theory, (3) the Innovation-Decision Process Theory, and (4) the Theory of Perceived Innovation Attributes.

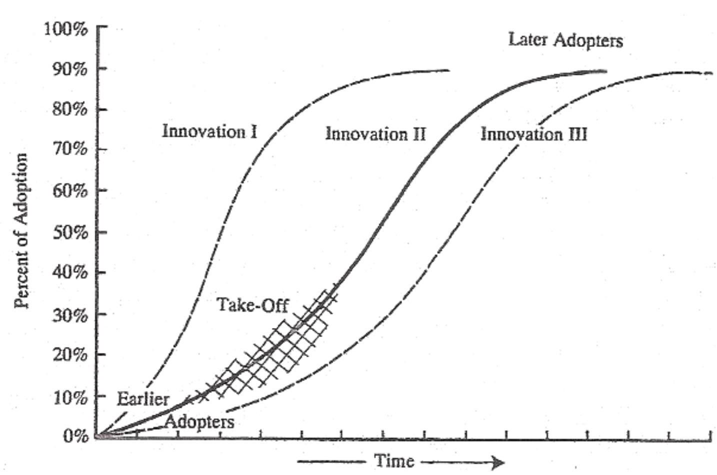
The Rate of Adoption Theory

The Rate of Adoption Theory contains four main elements that influence the adoption of an innovation by members of an organization: (1) the *innovation* (2) the *communication channels* used to spread information about the innovation, (3) *time*, and (4) the nature of the *social system* and its members. The elements (innovation, communication channels, time, and the social system) can be identified in every diffusion research study. The diffusion process is illustrated by plotting the number of individuals adopting the innovation on a cumulative frequency basis. The resulting distribution is an S-shaped curve. The majority of innovations have the S-shaped rate of adoption, however there is a variation in the slope of the S-shaped curve from innovation to innovation (Rogers, 2003). Figure 2 illustrates the diffusion process and shows how the slope of the S-Curve can vary from innovation to innovation depending on the rate of adoption. Innovation I has a much steeper slope showing a faster rate of adoption compared to Innovation II. Innovation III has a flatter slope showing that adoption took place over a much longer time period. The patterned area between 10 percent and 20 percent of adopters is identified as the “take off” area. This is the point at which an innovation is adopted by opinion leaders, and adoption by the rest of the social system takes off and spreads exponentially. The S-shaped curve of diffusion “takes off” once evaluation of the innovation spreads from peer to peer in a system. This “take off” area is the heart of the diffusion process. After the “take off” point has been reached it is often impossible to stop the further diffusion of an innovation (Rogers, 2003). The take off area is often referred to as the critical mass of satisfied adopters (Orr, 2003).

The S-shaped curve begins to level off after half of the individuals in a social system have adopted, because individuals who have not yet adopted become increasingly scarce, and it is more difficult for a peer to find another peer who does not know about the innovation (Rogers, 2003).

Figure 2

The Diffusion Process



Source: Rogers, E. (2003) Diffusions of Innovations. New York: Free Press

The S-shaped curve is innovation specific and only describes innovations that are adopted and diffused. However, it should be noted that many innovations are not adopted. Rogers (2003) discusses several examples of failed innovations. A classic example of nondiffusion is the Dvorak Keyboard. Professor August Dvorak conducted time-and-motion studies in 1932 and developed a more efficient keyboard than the QWERTY keyboard. The QWERTY keyboard was designed in 1873 to slow down typists in order to prevent the keys from jamming on early typewriters. The Dvorak Keyboard has the letters AOEUIDHTN and S on the home row. This arrangement balances out the work between the right and left hand whereas the QWERTY keyboard overloads the left hand. In addition, the Dvorak keyboard reduces the amount of jumping from row to row since 70 percent of typing is done on the home row compared to 32 percent on the QWERTY keyboard. In spite of its obvious advantages in reducing typing errors and reducing the possibility of carpal tunnel syndrome, almost no one has adopted the Dvorak keyboard in over seventy-six years since its introduction. In this case the innovation curve would be a nearly straight line running parallel to the X-axis.

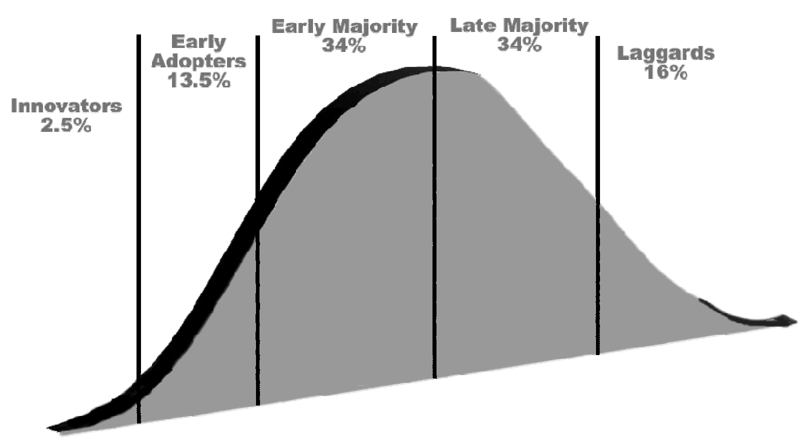
The Individual Innovativeness Theory

Individual Innovativeness Theory identifies that individuals who are pioneering and essentially “risk-immune” will adopt an innovation earlier than those who are very averse to risk and are essentially “risk-allergic” (Moore, 2001). Rogers (2003) developed the adopter categories in 1958 in response to the disarray of adopter categories among diffusion researchers that made it difficult for readers of research to compare findings about adopter categories from one study to another. The adopter categories are classifications of members of a social system on the basis of innovativeness. Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system. Innovativeness indicates overt behavioral change and is the desired main behavior in the diffusion process (p. 268).

Rogers (1995, 2003) used two parameters from the normal frequency distribution, the mean and the standard deviation to divide a normal adopter distribution into five categories: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. The adopter categories are ideal types based on observations of reality that are designed to make comparisons possible (p. 282). Figure 3 outlines the five adopter categories and the approximate percentage of individuals that are included in each category. Table 5 gives a description of the adopter categories and their characteristics.

Figure 3

Adopter Categories Based on Innovativeness



Source: Engaging Faculty: The Bell Curve of Faculty Technology adoption (Rogers, 2003; Vessell, 2007)

Moore (2001) suggested that there is a “chasm” between innovators and early adopters and the early majority, late majority, and laggards due to the more cautious nature of the latter. He posited that early adopters do not necessarily influence the early majority because the characteristics between the two groups are vastly different. It is the difference between visionaries (early adopters) and pragmatists (early majority). Moore stated that the transition between these two groups is difficult in practice and may not occur. However, Rogers (2003) redirected on this point. He contended that there was no research to support the claim of a “chasm”, and that if measured properly, innovativeness is a continuous variable without sharp breaks or discontinuities between adjacent adopter categories (p. 282)

Table 5

Description of Rogers Adopter Categories

Adopter Category	Description of Adopter Characteristics
Innovators	The first 2.5% of adopters are *venturesome*, well educated, and have substantial control of financial resources that cushions the possible loss from an unprofitable innovation. Innovators are risk takers and can tolerate a high degree of uncertainty.
Early Adopters	The next 13.5% of adopters are the *respected* social leaders, and are more integrated into the local system than innovators. Early adopters have the highest degree of opinion leadership in most systems, and serve as role models. Early adopters help trigger the critical mass when they adopt an innovation, and they are the category that is generally sought by change agents.
Early Majority	The next 34% of adopters are *deliberate* in making the decision to adopt. Their innovation-decision process is longer than that of the innovators and early adopters. The early majority tends to adopt an innovation just before the average member of a system. Although they interact frequently with their peers, they are seldom opinion leaders. The early majority are an important link in the diffusion process. They provide connection to the system's interpersonal networks.
Late Majority	The next 34% of adopters are *skeptical* and cautious in making the decision to adopt an innovation. The late majority adopts just after the average member of a system. The late majority does not adopt until most others in their system have already done so. The system norms must favor an innovation, and adoption may be economic necessity as well as a result of peer pressure.
Laggards	The last 16% of adopters are very *traditional* in the decision to adopt an innovation. Laggards' innovation-decision making point of reference is what has been done previously, and adoption and use lag far behind awareness and knowledge of a new innovation. Laggards' resources are limited and they must be certain a new idea will not fail before they can adopt. Laggards possess almost no opinion leadership and they interact primarily with others who also have relatively traditional values. Laggards tend to be suspicious of innovations and change agents.
Source: Rogers, E. (2003) Diffusions of Innovations. New York: Free Press	

The Innovation-Decision Process Theory

The Innovation-Decision Process Theory is described by Rogers (2003) as an information-seeking and information-processing activity where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation (p. 172). The innovation-decision process involves five steps: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. The stages typically follow each other in a time-ordered manner.

At the Knowledge-Stage the individual learns about the existence of an innovation and seeks information. The individual attempts to determine what the innovation is and how and why it works (Rogers, 2003, p.21). In the Persuasion Stage the individual has a negative or positive attitude toward the innovation, but the formation of a favorable or unfavorable attitude does not always lead directly or indirectly to an adoption or rejection. The persuasion stage is more affective (or feeling) centered in contrast to the knowledge stage which is more cognitive. The individual seeks subjective evaluations from close peers about the innovation to reduce uncertainty about innovation outcomes. The peers' evaluations are more credible to the individual than outside experts (Rogers, 2003, p. 176).

At the Decision Stage the individual chooses to adopt or reject the innovation. The Decision Stage is followed by the Implementation Stage in which the innovation is put into use. At the implementation stage the implementer may need technical assistance from change agents and others. Reinvention usually happens at the implementation state and is an important part. Reinvention is the degree to which an innovation is changed or modified by a user in the process of its adoption (Rogers, 2003, p. 180).

In the final stage which is the Confirmation Stage, the innovation-decision has been made and implemented and the individual looks for support for his or her decision. The adoption decision can be reversed if the individual is exposed to conflicting messages about the innovation. The discontinuance decision can come in two ways. The individual can reject the innovation for a better innovation replacing it, and the individual can reject the innovation because he or she is not satisfied with its performance (Rogers, 2003, p.189).

The Theory of Perceived Innovation Attributes

The Theory of Perceived Innovation Attributes is the final theoretical perspective organized by Rogers (2003) under the meta-theory of diffusion of innovations. He describes the innovation-diffusion process as an uncertainty reduction process (p.232), and he proposes five attributes of innovations that help to decrease uncertainty about the innovation. The five attributes are: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. The individuals' perceptions of these characteristics predict the rate of adoption of innovations (p. 219).

Many studies use Rogers (1995) theory as a theoretical framework, however, very few of those studies investigate the use of computers in classroom instruction. Isleem (2003) conducted a quantitative study of the level of computer use in instruction by technology education teachers in Ohio public schools using diffusion theory. The relationships between the level of computer use and selected factors: expertise, access, attitude, support, and teacher characteristics were examined. He found that teachers' perceived expertise, perceived access to computers, and perceived attitude toward computers were the significant predictors of the level of computer use (Isleem, 2003). There were similar findings in several other related studies. Attitude, support, access, age, and training were found to be statistically significant predictors of computer use in classroom instruction. Although teachers used computers for research and professional communications, their adoption of computers in instruction was very low (Anderson, Varnhagen, & Campbell, 1998; Blankenship, 1998; Carter, 1998; Surendra, 2001; Zakaria, 2001). Rogers' (1995) attributes of innovations, diffusion factors, and adopter categories were found to be useful predictors of the adoption of an innovation (Anderson et al., 1998; Less, 2003; Surendra, 2001).

Most innovation research is concerned with three basic research questions that provide a unifying theme across disciplines and traditions. The basic questions are concerned first with determining the rate, pattern, and extent of diffusion of an innovation across a population of potential adopters; second with determining the general propensity of an organization to adopt and assimilate innovations over time; and third determining the propensity of an organization to adopt and assimilate a particular innovation (Fichman, 1999; Rogers, 1995).

This study was aligned most closely to the first and third categories. The pattern and extent of diffusion of a particular innovation (i.e. Wireless Mobile

Cart), and the attributes and practices of potential adopters are investigated (i.e. LoTi levels). DOI was the theoretical framework that informs the discussion of relevant literature for this study, the choice of methodology for data collection and analysis, as well as the interpretation of results. The rate of adoption theory, the individual innovativeness theory, and the innovation decision process theory were the main focus because they aid in the understanding of the relationship between teacher characteristics and the levels of technology implementation.

Barriers to Technology Implementation

The majority of the technology implementation studies reviewed for this research were aimed at either pre-service teachers or college professors rather than K-12 teachers. Nevertheless there were some insights concerning barriers to technology implementation that could be gathered from higher education studies, and some of these were included in this discussion.

Many studies that were conducted in the last 15 years identify common barriers to technology implementation that can be classified into two major types. The barrier categories are: (1) Systemic or Organizational and, (2) Individual or Member (Becker & Ravitz, 2001; Brown, 2004; CDW Government Inc., 2006; Hannafin & Savenye, 1993; Lam, 2000; Lancaster, 2000; Maguire, 2005; O'Dwyer, Russell, & Bebel, 2004; Shapley et al., 2006; Vaden, 2007).

Within the two broad categories of barriers there are dominant barriers that were identified across all studies this researcher reviewed.

Category 1 – Systemic or Organization Barriers: (1) lack of technology access (2) lack of Information Technology (IT) support, (3) lack of time to plan and learn how to integrate computers into the lessons and evaluate outcomes.

Category 2 – Individual or Member Barriers: (1) Teacher technology efficacy and proficiency (i.e., teacher attitudes toward technology use and teacher confidence in his or her ability to use technology), (2) Teacher philosophy/practice (i.e., teacher instructional practice that tends toward a teacher-centered or student-center method of teaching that impacts how technology is used).

Category 1 – (1) Lack of Technology Access

In spite of the nearly universal access to Internet-connected computers in schools across the U.S., and improved student to computer ratios, lack of "immediate" access (i.e. within the classroom) was still identified as a major barrier to technology implementation. Insufficient access is a serious impediment to technology implementation. In most schools the majority of computers were situated in labs which place access to Internet-connected computers "one step outside of the classroom". It is difficult for teachers to use computer technology in instruction as an everyday tool if they are located in a computer lab. This barrier prevents high level implementation from taking place (Lancaster, 2000; U.S. Department of Education Office of Educational Technology, 2004). Becker and Ravitz (2001) found that third grade teachers with as few as five to eight computers in their classroom were more likely to give students frequent computer experience during class than teachers of the same subjects whose classes used computers in a lab with 15 plus computers. The scheduling of whole classes of students at wide intervals in advance of need makes it almost impossible for computers to be integrated as research, analytic, and communicative tools in the context of the core academic work of a class (p. 7).

Vaden (2007) created an ideal classroom technology infrastructure model from an extensive literature review as the practical basis for assessing classroom technology infrastructure at Texas State University. His purpose was also to provide a measure for making recommendations to improve technology infrastructure. He identified six key components: (1) technology planning and policies, (2) equipment, (3) technology applications, (4) maintenance and support, (5) professional development, and (6) technology integration. The Vaden model suggests that technology equipment be located in the instructional setting providing availability for faculty and student use (p.28). Shapley, et. al (2006) issued the first report from a mixed method longitudinal study of the Texas Technology Immersion Pilot (eTxTIP) in June of 2006. The purpose of this research was to test the effectiveness of technology immersion on increasing middle school students' achievement in core academic subjects. This study followed three cohorts of students from sixth grade to ninth grade from the 2004-2005 school year to the 2007-2008 school year. The students were located across 44 middle school campuses. Half of these middle school campuses (22) implemented a technology immersion package. The other school sites (22) did not implement a technology immersion package, and were the "control" campuses.

Methods for data collection included administrator, teacher, and student pre- and post-surveys; student achievement information from the Texas Public Education Information Management System (PEIMS) and Academic Excellence Indicator System (AEIS) databases; as well as site visits to make classroom observations, and conduct individual and focus group interviews. Observations in sixth-grade classrooms in “immersed” schools highlighted the problem of inadequate computer access. Computer access was 15.1 laptops to 18.3 students on the average. Consequently some students either shared laptops or some students worked with paper and pencil while others used laptops. The teachers reported that not having enough laptops created the dual burden of providing technology-based and traditional paper-and-pencil lesson formats. Although access to computers does not guarantee computer integration (Lancaster, 2000), the availability of technology is positively related to its use both by students during class time and by teachers for preparation (O'Dwyer et al., 2004).

Category 1 – (2) Lack of Information Technology (IT) Support

The lack of IT or technical support is a theme that continues to appear in the literature. Technical support includes having adequate technology supplies as well as having timely technology updates and repairs (CDW Government Inc., 2006; Maguire, 2005; Vaden, 2007). Support must be readily available to assist in computer maintenance. When technological failures occur they must be handled immediately. If teachers believe that the computer is not a dependable tool for instruction, it will remain unused (Brown, 2004). O’Dwyer, et. al (2004) used hierarchical analysis in a longitudinal study to examine the variability in technology use within and between 96 schools covering grades K-6 in Massachusetts. Level of technology support was used as one of the teacher variables. At the individual teacher level, teachers were less likely to use technology if they had previously experienced problems integrating technology into the curriculum.

Category 1 – (3) Lack of Time to Plan, Learn, and Evaluate Outcomes

Time may very well be one of the biggest barriers to technology use (Brown, 2004; CDW Government Inc., 2006; Maguire, 2005). Lancaster (2000) suggested that teachers need extensive and sustained practice in order to develop the understanding and the skill levels to use technology well. Overcoming the fear of using new technology and redesigning teaching strategy requires a substantial investment in time. The more time teachers spend working with the new technology the more comfortable they become, and the more willing they are to experiment. A minimum of 30 hours of practice and experimentation was suggested as the amount of time teachers need to arrive at a basic level of comfort (Brown, 2004; Lancaster, 2000). Maguire (2005) reviewed over 40 studies that were conducted from 1990 to 2003. She created a comparison chart that grouped motivators and inhibitors to faculty technology use from 13 of these studies. Teachers identified the lack of time to develop and maintain course material and lack of release time as major barriers in 8 out of the 13 studies she reviewed.

Category 2 – (1) Teacher Technology Efficacy and Proficiency

Hannafin and Savenye (1993) examined reasons why some elementary and secondary school teachers resisted using computers that fit primarily into category 2 – (1). They identified frustration in how to use computers, the belief that time and effort to use was too great, the belief that software was poorly designed, not wanting to look stupid, fear of losing control, and not believing that computers enhance learning as reasons for teacher resistance to computer use.

Professional development training was consistently identified as a critical piece in the structure for successful technology implementation. It was identified as the necessary intervention that will help to increase teacher efficacy (i.e. belief that technology is useful for instruction) and teacher proficiency (CDW Government Inc., 2006; O'Dwyer et al., 2004; Vaden, 2007). Successful technology professional development should stem from a systematic support structure and must be on-going, not just a single event. The likelihood that a teacher will further his or her understanding and use of technology improves if there is someone who understands the technology and that is readily available (Brown, 2004).

Category 2 – (2) Teacher Philosophy/Practice

Many studies have identified teaching philosophy and practice as an important factor in determining how a teacher will use technology in instruction (Lam, 2000; Lancaster, 2000; O'Dwyer et al., 2004; Rakes, Fields, & Cox, 2006). It may be unfortunate that many technology implementation initiatives were tied early on to educational reform that tended to push constructivist practices. Harris (2005) offered two primary reasons for the perception that most large-scale technology integration efforts have failed: (1) technocentrism and (2) pedagogical dogmatism. Teachers who embrace the traditional teacher centered instructional practices may feel very hostile toward the not so secret agenda to change their teaching practices along with the implementation of technology in the classroom. Constructivist instructional methods are very student centered.

Harris (2005) stated that there are ethical difficulties with assuming that educational technology use “should” favor student-centered, constructivist modes of learning and teaching. She suggested that this may infringe on academic freedom, and interferes with the teacher’s ability to apply a well informed decision to choose a methodological approach based on the context of the school and community, and the individual students’ learning needs and preferences (p.120). Harris (2005) also argued that after two decades of effort, technology as a “Trojan horse” for educational reform has succeeded in only a minority of K-12 contexts. She further argued that considering the largely unstated and unsuccessful technology agenda to change the nature of teaching and learning, perhaps a new approach is warranted – one that genuinely respects pedagogical plurality and honors teachers’ academic freedom.

Category 2 barriers tend to slow down the rate of adoption or implementation of technology innovations, however, Category 1 barriers cause individuals or organizations to reject rather than adopt or implement an innovation. Since Category 1 barriers are systemic and physical, they can be more easily removed than Category 2 barriers. Category 2 barriers apply to individual member attributes. Effective removal of Category 2 barriers requires an effort by change agents to overcome pro-innovation bias.

The Framework for Measuring Technology Use

Moersch (1995) created a framework called Levels of Technology Implementation (LoTi) for measuring classroom technology use. The LoTi framework is grounded in the work of David Dwyer and Apple Classrooms of Tomorrow (ACOT). The decade long ACOT research project identified that as a teacher successfully integrates technology in the classroom there is a shift in classroom activity from teacher-centered to learner centered; a change in teacher and student roles; a shift in instructional emphasis from memorization to inquiry and invention; a change in the concept of knowledge from accumulating facts to transforming facts; and technology use shifts from drill and practice to communication, collaboration, information access, and expression. In addition, assessment of success shifts from emphasis on quantity and multiple-choice to quality of understanding, portfolios, and performances (Dwyer, 1994).

The 1995 LoTi framework proposes seven discrete implementation levels that range from Nonuse (Level 0) to Refinement (Level 6). Level 4 is identified as the lowest level of performance that is considered to be an *authentic* use of technology. At this level teachers integrate technology-based tools to provide a rich context for students' understanding of the pertinent concepts, themes, and processes. Technology is perceived as a tool to identify and solve authentic problems relating to an overall theme/concept (Moersch, 1995). The LoTi framework was updated the following year in 1996. Level 4 was subdivided into 4a and 4b creating eight levels instead of seven. The following are the eight implementation levels in detail:

- Level 0 – Nonuse: There is a perceived lack of access to technology-based tools (e.g. computers) or a lack of time to pursue electronic technology implementation. Existing technology is predominately text-based (e.g., ditto sheets, chalkboard, and overhead projector).
- Level 1 – Awareness: The use of technology-based tools is either (1) one step removed from the classroom teacher (e.g., integrated learning system labs, special computer-based pull-out programs, computer literacy classes, central word processing labs), (2) used almost exclusively by the classroom teacher for classroom and/or curriculum management tasks (e.g., taking attendance, using grade book programs, accessing email, retrieving lesson plans from a curriculum management system or the Internet) and/or (3) used to embellish or enhance teacher-directed lessons or lectures (e.g. multimedia presentations).
- Level 2 – Exploration: Technology based tools supplement the existing instructional program (e.g., tutorials, educational games, and basic skill applications) or complement selected multimedia and/or web-based projects (e.g., Internet-based research papers, informational multimedia presentations) at the

knowledge/comprehension level. The electronic technology is employed either as extension activities, enrichment exercises, or technology-based tools and generally reinforces lower cognitive skill development relating to the content under investigation.

- Level 3 – Infusion: Technology-based tools including databases, spreadsheet and graphing packages, multimedia and desktop publishing applications, and Internet use complement selected instructional events (e.g., field investigation using spreadsheets/graphs to analyze results from local water quality samples) or multimedia/web based projects at the analysis, synthesis, and evaluation levels. Though the learning activity may or may not be perceived as authentic by the student, emphasis is, nonetheless, placed on higher levels of cognitive processing and in-depth treatment of the content using a variety of thinking skill strategies (e.g. problem-solving, decision-making, reflective thinking, experimentation, scientific inquiry).
- Level 4a – Integration (Mechanical): Technology-based tools are integrated in a mechanical manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and/or outside resources (e.g., assistance from other colleagues), and/or interventions (e.g., professional development workshops) that aid the teacher in the daily management of their operational

curriculum. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems as perceived by the students relating to an overall theme/concept. Emphasis is placed on student action and on issues resolution that require higher levels of student cognitive processing and in-depth examination of the content.

- Level 4b – Integration (Routine): Technology-based tools are integrated in a routine manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. At this level, teachers can readily design and implement learning experiences (e.g., units of instruction) that empower students to identify and solve authentic problems relating to an overall theme/concept using the available technology (e.g. multimedia applications, Internet, databases, spreadsheets, word processing) with little or no outside assistance. Emphasis is again placed on student action and on issues resolution that require higher levels of student cognitive processing and in-depth examination of the content.
- Level 5 – Expansion: Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from other schools, business enterprises, governmental agencies (e.g. contacting NASA to

establish a link to an orbiting space shuttle via Internet), research institutions, and universities to expand student experiences directed at problem-solving, issues resolution, and student activism surrounding a major theme/concept. The complexity and sophistication of the technology-based tools used in the learning environment are now commensurate with (1) the diversity, inventiveness, and spontaneity of the teacher's experiential-based approach to teaching and learning and (2) the students' level of complex thinking (e.g., analysis, synthesis, evaluation) and in-depth understanding of the content experienced in the classroom.

- Level 6 – Refinement: Technology is perceived as a process, product (e.g., invention, patent, new software design), and/or tool for students to find solutions related to an identified "real-world" problem or issue of significance to them. At this level, there is no longer a division between instruction and technology use in the classroom. Technology provides a seamless medium for information queries, problem-solving, and/or product development. Students have ready access to and complete understanding of a vast array of technology based tools to accomplish any particular task at school. The instructional curriculum is entirely learner-based. The content emerges based on the needs of the learner according to his/her interests, needs, and/or aspirations and is supported by unlimited access to the most current computer applications and infrastructure available (Moersch, 1996, pg. 53).

As a teacher progresses from one LoTi level to the next, a series of changes to the instructional curriculum is observed. The instructional focus shifts from being teacher-centered to being learner-centered. Computer technology is employed as a tool that supports and extends students' understanding of the pertinent concepts, processes, and themes involved when using software applications.

The eight discrete implementation levels that range from Nonuse (level 0) to Refinement (Level 6) have a conceptual alignment to the Concerns-Based Adoption Model that identifies seven stages of concern that teachers experience as they adopt a new practice: (1) Awareness (2) Informational (3) Personal (4) Management (5) Consequence (6) Collaboration (7) Refocusing (Hall & Loucks, 1979)

There are six separate surveys within the LoTi framework: higher education faculty, school administrators, media specialists, instructional specialists, pre-service teachers, and in-service teachers (Moersch, 2002). The LoTiQ is the original instrument that was developed from the stages of the LoTi framework for in-service teachers and investigates teachers' self perceptions of their own technology use. The other surveys were developed from the original in-service version and contain changes in the questions to reflect the different professional roles (Stoltzfus, 2005).

Moersch (1996) created these survey instruments to provide school administrators and stakeholders with specific needs assessment data to help shape future decision making around budgeting priorities, instruction and assessment issues, and professional development options. He stated that in the case of LoTiQ, he wanted a survey that would align with the existing LoTi framework, focus attention more on instruction and assessment practices rather than technology, and provide a tool that could be used in research studies and dissertations as well as by school systems worldwide (Moersch, 1996).

The 50-item LoTiQ is a multidimensional instrument that measures three distinct areas of teachers' technology practices: (a) Level of Technology Implementation (LoTi); (b) Personal Computer Use (PCU); and (c) Current Instructional Practices (CIP). Forty items of the survey determine the LoTi level ranging from Nonuse (Level 0) to refinement (Level 6). There are five items that measure PCU and five items that measure CIP (Stoltzfus, 2005). PCU identifies the proficiency and comfort level of a teacher with using a computer. CIP measures the extent to which a teachers' instructional practices are student-centered, collaborative and constructivist (Moersch, 1996)

Personal Computer Use (PCU) Framework

Level 0 - Indicates that the participant does not feel comfortable or have the skill level to use computers for personal use. Participants at Intensity Level 0 rely more on the use of overhead projectors, chalkboards, and/or traditional paper/pencil activities than using computers for conveying information or classroom management tasks.

Level 1 - Indicates that the participant demonstrates little skill level with using computers for personal use. Participants at Intensity Level 1 may have a general awareness of various technology-related tools such as word processors, spreadsheets, or the Internet, but generally are not using them.

Level 2 - Indicates that the participant demonstrates little to moderate skill level with using computers for personal use. Participants at Intensity Level 2 may occasionally browse the Internet, use email, or use a word processor program; yet, may not have the confidence or feel comfortable troubleshooting simple "technology" problems or glitches as they arise. At school, their use of computers may be limited to a grade book or attendance program.

Level 3 - Indicates that the participant demonstrates moderate skill level with using computers for personal use. Participants at Intensity Level 3 may begin to become "regular" users of selected applications such as Internet browsers, email, or word processor program. They may also feel comfortable troubleshooting simple "technology" problems such as rebooting a machine or hitting the "Back" button on an Internet browser, but mostly rely on technology support staff or others to assist them with any troubleshooting issues.

Level 4 - Indicates that the participant demonstrates moderate to high skill level with using computers for personal use. Participants at Intensity Level 4 commonly use a broader range of software applications including multimedia (e.g., Microsoft PowerPoint), spreadsheets, and simple database applications. They typically have the confidence and are able to troubleshoot simple hardware, software, and/or peripheral problems without assistance from technology support staff.

Level 5 - Indicates that the participant demonstrates high skill level with using computers for personal use. Participants at Intensity Level 5 are commonly able to use the computer to create their own web pages, produce sophisticated multimedia products, and/or effortlessly use common productivity applications (e.g., Microsoft Excel, FileMaker Pro), desktop publishing software, and web-based tools. They are also able to confidently troubleshoot most hardware, software, and/or peripheral problems without assistance from technology support staff.

Level 6 - Indicates that the participant demonstrates high to extremely high skill level with using computers for personal use. Participants at Intensity Level 6 are sophisticated in the use of most, if not all, multimedia, productivity, desktop publishing, and web-based applications. They typically serve as "troubleshooters" for others in need of assistance and sometimes seek certification for achieving selected technology-related skills.

Level 7 - Indicates that the participant demonstrates extremely high skill level with using computers for personal use. Participants at Intensity Level 7 are expert computer users, troubleshooters, and/or technology mentors. They typically are involved in training others on any technology-related tasks and are usually involved in selected support groups from around the world that allow them access to answers for all technology-based inquiries they may have (Learning Quest Inc., 2008).

Current Instructional Practices (CIP) Framework

CIP Intensity Level 0 - Indicates that one or more questionnaire statements were not applicable to the participant's current instructional practices.

CIP Intensity Level 1 - At CIP Intensity Level 1 the participant's current instructional practices align exclusively with a subject-matter based approach to teaching and learning. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions. Student projects tend to be teacher-directed in terms of identifying project outcomes as well as requirements for project completion.

CIP Intensity Level 2 - The participant at CIP Intensity Level 2 supports instructional practices consistent with a subject-matter based approach to teaching and learning, but not at the same level of intensity or commitment. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions. Student projects tend to be teacher directed in terms of identifying project outcomes as well as requirements for project completion.

CIP Intensity Level 3 - At CIP Intensity Level 3, the participant supports instructional practices aligned somewhat with subject-matter based approach to teaching and learning – an approach characterized by sequential and uniform learning activities for all students, teacher-directed presentations, and/or the use of traditional evaluation techniques. However, the participant may also support the use of student-directed projects that provide opportunities for students to determine the “look and feel” of a final product based on specific content standards.

CIP Intensity Level 4 - At CIP Intensity Level 3, the participant supports instructional practices aligned somewhat with subject-matter based approach to teaching and learning – an approach characterized by sequential and uniform learning activities for all students, teacher-directed presentations, and/or the use of traditional evaluation techniques. However, the participant may also support the use of student-directed projects that provide opportunities for students to determine the “look and feel” of a final product based on specific content standards.

CIP Intensity Level 5 - At CIP Intensity Level 5, the participant’s instructional practices tend to lean more toward a learner-based approach. The essential content embedded in the standards emerges based on student’s “need to know” as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Both students and teachers are involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed. However, the use of teacher-directed activities (e.g., lectures,

CIP Intensity Level 6 - Similar to CIP Intensity Level 7, the participant at CIP Intensity Level 6 supports instructional practices consistent with learner-based approach, but not at the same level of intensity or commitment. The essential content embedded in the standards emerges based on students' "need to know" as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based journals, peer reviews, self-reflections) by which student performance will be assessed.

CIP Intensity Level 7 - At CIP Intensity Level 7, the participant's current instructional practices align exclusively with a learner-based approach to teaching and learning. The essential content embedded in the standards emerges based on students' "need to know" as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based journals, peer reviews, self-reflections) by which student performance will be assessed (Learning Quest Inc., 2008).

The LoTi Framework also has a conceptual parallel to Rogers (1995) diffusion and assimilation of technology innovations. One can reason intuitively that early adopters would move through the LoTi levels very quickly up to levels 5 and 6. Early adopters possess the particular characteristics of exemplary computer users that are identified in the concepts of PCU and CIP at higher intensity levels as measured by LoTiQ. Late adopters would probably move very slowly through the levels and would more likely tend to remain on the lower LoTi levels 0-2. Late adopters have particular characteristic that are mirrored by PCU and CIP at lower intensity levels. Early and Late Majority adopters would be more likely to move at a moderate rate up to levels 4a and 4b. Majority adopters have characteristics that are reflected by a moderate intensity of CIP and PCU.

Other models that measure technology use were considered for use in this study: the Technology Acceptance Model (TAM) and the Technology Integration Pre-Survey for Teachers (TIPS-T). The TAM measures the likelihood that teachers will adopt a particular innovation based on a survey of teacher perceptions concerning perceived usefulness (PU) and ease of use (EOU)(Davis, 1989). The TIPS-T identifies teacher technology proficiency for specific technologies on a scale from one (non-user) to five (expert). However, the LoTiQ is the most appropriate for use in this study because it focuses on technology as an interactive learning medium at the classroom level, and comes closest to measuring the fidelity of implementation of technology in the classroom.

Summary

Capital investments of billions of dollars have been spent on educational technology nationwide providing teachers with nearly universal computer and Internet access. Nevertheless, many teachers are not using that technology to maximize teaching and learning in the classroom. Given that the average K-12 student ages 5-17 can competently use Internet-connected computer technology for a variety of purposes, this technology has the tremendous potential for increasing student engagement in learning across the board. Student engagement is difficult to define operationally, nevertheless most of us know it when we see it, and we know when it is missing. Student engagement has been recognized by teachers and researchers alike as an important link to student achievement and other learning outcomes (Renzulli, 2008; Sandholtz, Ringstaff, & Dwyer, 1991). Internet-connected computer technology also has great potential for application to issues of remediation for struggling students, and is especially useful for individualizing instruction for the special needs student.

Since the majority of the funds for technology come from public sources there is an increasing demand to demonstrate the effectiveness of technology driven instructional interventions. As a result there is a growing trend to assess teachers' technology use rather than merely measuring the percent of Internet-connected computers and student to computer ratios (Learning Point Associates, 2007; Moersch, 2002).

Improvement of student achievement was one of the main goals of NCLB Title II, Part D which appropriated one billion dollars each year from 2002 to 2007 to provide technology grants to states and local schools to support technology initiatives to build technology infrastructure. However, few studies investigating the correlation between technology implementation and student achievement conclude technology implementation has a positive effect on student achievement.

Rogers (1995, 2003) Diffusion of Innovations (DOI) was the theoretical framework that informed the literature review, choice of methodology for data collection and analysis, and the interpretation of results in this study. Moersch (1995) created a framework for investigating teacher technology implementation that has a conceptual parallel to DOI theories. The LoTiQ was developed to align with the LoTi framework, and provides a way for administrators and stakeholders to obtain specific needs assessment data to help shape decisions concerning technology expenditures (Moersch, 1996). Other models and frameworks were considered for use in this study, however, the LoTiQ was selected because it focuses on technology as an interactive learning medium at the classroom level.

The majority of technology implementation studies identify common barriers to technology implementation. These barriers can be classified into two major categories: (1) Systemic or Organizational and, (2) Individual or Member. Category 2 barriers slow down the rate of technology adoption or implementation of technology innovations, whereas Category 1 barriers cause individuals or organizations to reject rather than adopt or implement an innovation.

CHAPTER III - METHODOLOGY

Introduction

This study investigated teacher technology proficiency/efficacy (PCU) teacher current instructional practice (CIP), and teacher/student technology access (WMCA). These are the factors that have the greatest potential for change through technology acquisition and professional development (Goddard, Hoy & Wolfolk-Hoy, 2000). The questions that guided this research were:

1. What is the level of teacher and student access to wireless mobile cart technology (WMCA)?
2. What is the current level of technology implementation (C-LoTi) in the district?
3. Does wireless mobile cart access relate to the current level of technology implementation(C-LoTi) in the district?
4. What is the level of teacher technology proficiency/efficacy (PCU)?
5. Does the level of teacher technology proficiency/efficacy (PCU) relate to the current level of technology implementation (C-LoTi) in the district?
6. Is teacher-centered or learner-centered practice the more predominant Current Instructional Practice (CIP)?

7. Is there a relationship between Current Instructional Practice (CIP) and the current level of technology implementation (C-Loti) in the district?

Research Design

A cross-sectional survey design was used to investigate the effects of wireless mobile cart access on the level of in-service teachers' technology implementation. The purpose of the cross-sectional survey design is to describe the attitudes, opinions, preferences, demographics, practices, and procedures at one point in time of a selected sample that can be generalized to a population. This method is appropriate for investigating a variety of educational problems and issues and for studies that use the Diffusion of Innovations (DOI) theory as a framework (Gay & Arasian, 2000; Rogers, 2003). This study was informed by DOI theory and investigated teacher perceptions of technology use. Therefore, the cross-sectional survey design was especially appropriate.

Methods

Population and Sample

The target population for this study was certified teachers employed by a Pre-Kindergarten to 12th grade urban school district located in a Southwestern U.S. city. According to the 2006/2007 district federal accountability data obtained from the school district website, there are 2,437 certified teachers, and 35,245 students. Fifty-seven percent of the schools in the district were classified as Title I schools with 87 percent of the student population on free and reduced lunch.

There were 87 schools spread across a 135 square mile area. Sixty (60) of the 87 schools were elementary schools, sixteen (16) were middle schools, and eleven (11) were high schools. The 87 schools were arranged into six learning communities. Each learning community contained all of the elementary and middle schools that fed students into the high school(s) and that served a particular geographic area. For this study, each learning community was assigned a number from 1 to 6 in order to preserve anonymity. There were 714 high school teachers, 308 middle school teachers, and 1415 elementary school teachers with 523, 199, 518, 516, 541, and 140 teachers in learning communities 1-6 respectively.

The certified teachers in the Southwestern urban school district had an average of 13.7 years of teaching experience, and 86 percent met the NCLB standards for being highly qualified. Table 6 shows the professional qualification of teachers who taught in the core academic subjects: English, reading or language arts, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography:

Table 6

Professional Qualifications of Teachers in Core Academic Subject Areas

Education Level	Bachelors Degree	Masters Degree	Doctorate Degree
Percent of Teachers	66%	32.9%	0.6%

The ethnic and gender makeup of teachers is outlined in Table 7.

Table 7

Teacher Demographics

Ethnicity	Male	Female	Total	Percent of Total Population
African American	120	337	457	19%
American Indian	6	24	30	1%
Asian	7	21	28	1%
Hispanic	17	74	91	4%
White	380	1451	1831	75%
Category Total	530	1907	2437	
Percent of Total	22%	78%	100%	
Source: Annual District Statistical Report 2006-2007				

A proportional stratified random sampling procedure was used to ensure that Learning Communities and grade levels taught were represented in the same proportion in the sample as in the entire population. Stratification was done based on membership in Learning Communities 1-6, and level of instruction: elementary, middle, or high school. This created 18 strata. Each teacher drawn for the sample from each stratum was selected using a table of ten thousand random numbers (Gay & Arasian, 2000). Table 8 shows the 18 strata which include the number of teachers on each instructional level in each learning community. The number of teachers on each instructional level in each learning community is also shown as a percent of the total number of teachers in the district.

Table 8

Proportionate Sample Stratification

Learning Community	1		2		3		4		5		6		Grand Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
High School Teachers	108	4%	93	4%	117	5%	229	9%	125	5%	42	2%	714	29%
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Middle School Teachers	73	3%	--	--	109	5%	30	1%	66	3%	30	1%	308	13%
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Elementary School Teachers	342	14%	106	4%	292	12%	257	11%	350	14%	68	3%	1415	58%
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Learning Community Totals	523	21%	199	8%	518	22%	516	21%	541	22%	140	6%	2,437	100%

A sample size table developed by Bartlett, Kotrlik, and Higgins (2001) that was based on Cochran's (1977) formula was used to determine the *required* sample size (*n=119).* This table distinguished between continuous data and categorical data. A smaller *required* sample is needed for continuous data. This study collected continuous data. The *drawn* sample was determined by dividing the *required* sample size by the expected response rate (119/.198 = 600)(Watson, 2001). This formula takes into account prior research response rates. McAdoo (2005) surveyed the entire certified population of 2,238 in this district, and achieved a 17.4 percent (*n=390*) return rate with two email contacts. The *drawn* sample size for this study was based on considering the prior 17.4 percent response rate with an estimated improvement that was expected from following Dillman's four contact method. Six hundred (600) was the *drawn* sample size based on the Watson's (2001) formula, and by plugging in an estimated 19 percent response rate.

Table 9 shows how many participants for the *drawn* sample were selected from each learning community using Table 9 - Proportionate Sample Stratification.

Table 9

Drawn Sample by Learning Community and Grade Level

Learning Communities	1	%	2	%	3	%	4	%	5	%	6	%	Total
High School Teachers	24	4%	24	4%	30	5%	54	9%	30	5%	12	2%	174
Middle School Teachers	18	3%	-	-	30	5%	6	1%	18	3%	6	1%	78
Elementary School Teachers	84	14%	24	4%	72	12%	66	11%	84	14%	18	3%	348
Learning Community Total Teachers Selected	126	21%	48	8%	132	22%	126	21%	132	22%	36	6%	600

From a potential 600 participants, 83 teachers took the online LoTiQ survey. This sample size was sufficient for a behavior science study, as it fell within the guidelines for a minimum of 30 participants up to 500 participants for ex post facto (independent variable is not manipulated) research. Thirty or more participants allows the researcher to benefit from the application of the central limit theorem to the study (Hill, 1998).

Although the response rate was somewhat lower than anticipated (30 percent less), the composition of the sample was similar to that of the population. The percentage of male and female respondents was closely aligned with the population percentage of males and females. Male participants constituted 23 percent of those responding, and female participants constituted 77 percent of those responding. In the population, the percent of males is 22 percent and the percent of females is 78 percent.

Fifty percent of the participants held a bachelors degree, 49 percent held a masters degree, and one percent held a doctorate degree. This was similar to the population data which showed that 66 percent of certified teachers held a bachelors degree, 32.9 percent held a masters degree, and 0.6 percent held a doctorate degree.

The participant data on school level taught also showed a generally consistent alignment with district data. However, there was a somewhat higher representation among middle school teachers.

Table 10 presents sample demographic information compared to district demographic information that was provided by the School District Planning, Research, and Evaluation Department (PRE) in the 2006-2007 Annual District Statistical Report.

Table 10

Comparison of Sample and Population on Gender, Level of Education, and School Level Taught

	Gender		Level of Education			School Level Taught		
	M	F	Bachelors	Masters	Doctorate	High	Middle	Elementary
Sample (*N*)	19	65	41	40	1	19	29	36
	23%	77%	50%	49%	1%	23%	35%	43%
Population	530	1907	1618	804	15	714	308	1415
	22%	78%	66%	32.9%	0.6%	29%	13%	58%

Learning communities were generally proportionately represented in line with the stratification process outlined in Table 9. Learning community 6 had a somewhat higher percent of representation than anticipated.

Almost half (43 percent) of the participants responding to the survey reported their age as 51 and over, 25 percent were 31 to 40 years old, 22 percent were 41 to 50 years old, and 9 percent were 21 to 30 years old. The majority (65 percent) of participants were over 40 years old.

More than half of the participants (65 percent) reported having ten or more years of teaching experience, while 16 percent reported having five to nine years, and 20 percent reported having less than five years. The Annual District Statistical Report for 2006-2007 reflected that certified teachers had an average of 13.7 years of teaching experience. Only one respondent failed to give information on age or years of teaching experience.

Table 11 presents the sample age range, years of teaching experience, and percent of participants by learning community. The six learning communities which consist of all the elementary and middle schools that feed students into a high school in a particular geographic area were numbered 1 through 6 to preserve anonymity.

Table 11

Participant Age, Years of Teaching, and Percent of Participants by Learning Community

Participants by Learning Community			Age Range			Years of Teaching		
Learning Community	#	%	Range	#	%	Range	#	%
1	13	16%	21-30	7	9%	< 5 Yrs	16	20%
2	5	6%	31-40	21	25%	5-9 Yrs	14	16%
3	10	12%	41-50	18	22%	10-20 Yrs	35	43%
4	14	17%	51 & Over	36	43%	> 20 Yrs	18	22%
5	14	17%						
6	27	33%						
Total	83	100%		82	99%		82	99%

Instrumentation

This study used the entire LoTiQ instrument (Appendix A) with six general demographic questions, and four technology use questions constructed by the researcher added to collect data. Moersch (1995) developed the LoTi framework in 1995, and the LoTiQ in 2001 as a way to measure *authentic* technology use, and to offer some basic recommendations to school districts that are preparing technology expansion plans (Moersch, 1995, 2001).

The 50 item LoTiQ is a multidimensional instrument that measures three major aspects of teachers' technology use: (a) Level of Technology Implementation (LoTi); (b) Personal Computer Use (PCU); and (c) Current Instructional Practices (CIP).

Figure 4 outlines the eight implementation levels of the LoTi.

Figure 4

Levels of Technology Implementation (LoTi) Framework

LoTi Framework Level	Description
Level 0 - Nonuse	A perceived lack o access to technology-based tools or a lack of time to pursue electronic technology implementation. Existing technology is predominately text-based (e.g. ditto sheets, chalkboard, and overhead projector).
Level 1 - Awareness	The use of computers is generally one step removed from the classroom teacher (e.g., it occurs in integrated learning system labs, special computer based pull-out programs, computer literacy classes, and central word processing labs). Computer-based applications have little or no relevance to the individual teacher's instructional program.
Level 2 - Exploration	Technology-based tools serve as a supplement (e.g., tutorials, educational games, simulations) to the existing instructional program. The electronic technology is employed either for extension activities or for enrichment exercises to the instructional program.
Level 3 - Infusion	Technology-based tools including databases, spreadsheets, graphing packages, probes calculators, multimedia applications, desktop publishing, and telecommunications augment selected instructional events (e.g. science kit experiments using spreadsheets or graphs to analyze results, telecommunications activities involving data sharing among schools).
Level 4a – Integration (Mechanical)	Technology-based tools are mechanically integrated, providing a rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and sequential charts that aid the teacher in the daily operation of the instructional curriculum. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems relating to an overall theme or concept.
Level 4b – Integration (Routine)	Teachers can readily create integrated units with little intervention from outside resources. Technology-based tools are easily and routinely integrated, providing a rich context for students' understanding of the pertinent concepts, themes, and processes. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems relating to an overall theme or concept.
Level 5 - Expansion	Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from business enterprises, government agencies (e.g., contacting NASA to establish a link to an orbiting space shuttle through the Internet), research institutions, and universities to expand student experiences directed at problem solving, issues resolution, and student activism surrounding a major theme or concept.
Level 6 - Refinement	Technology is perceived as a process, product (e.g., invention, patent new software design), and tool for students to use in solving authentic problems related to an identified real-world problem or issue. In this context, technology provides a seamless medium for information queries, problem solving, and product development. Students have ready access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task.
From "Computer Efficiency: Measuring The Instructional Use of Technology" by C. Moersch, 1996, *Learning and Leading with Technology,* December/January, P. 53.	

The content validity and construct validity of the LoTiQ was established by various independent research studies over a period of ten years of use in over twenty U. S. states. Using Cronbach's alpha, Schechter (2000) and Larson (2003) reported an internal reliability coefficient of r=.74 and r=.85 respectively for the LoTiQ as a whole, and identified significant correlations between LoTi levels and the PCU and CIP components.

Content validity was determined in 1997 and 1998 through an expert panel process. A panel of instructional technology educators employed by the Los Angeles Unified School District developed LoTiQ items. A pilot study was conducted by Moersch (1995) that investigated the question: How accurate are inferences about a person's level of technology implementation when these inferences are based on LoTi Survey responses? A standardized classroom observation form with a specific LoTi level assigned to each teacher based on their interview responses was compared to LoTiQ responses. This pilot study found a strong correlation between the estimated LoTi levels based on interviews, and the actual LoTi questionnaire scores (Stoltzfus, 2005).

Stoltzfus (2005) determined construct validity through the use of a 38-item five-factor promaxian model that was applied to a large random sample (n=3,770) drawn from a national population of 47,956 Pre-kindergarten to 12th grade teachers who completed the in-service survey during the 2003-2004 academic year. Cronbach's alpha was used to compute internal consistency for the five-factor solution. All five factors revealed strong internal consistency with values ranging from .66 to .93. In addition a bivariate interfactor correlation matrix showed that the LoTi Survey domains are strongly intercorrelated. (Stoltzfus, 2005).

Procedures

The LoTiQ survey was administered in an online format to minimize classroom intrusion, and increase the convenience of taking the survey for participants. In addition, the online format economized on the amount of time and personnel needed to collect data.

The survey website was set up by National Business Education Alliance (NBEA) on their secure server on May 6, 2008 following application and approval for the use of the LoTiQ and payment of fees. NBEA set up the LoTiQ Survey on their secure server. The survey allowed participants to create user ID and passwords known only to the participant which preserved anonymity.

Letters of invitation along with the informed consent form were mailed to the *drawn* sample of 600 teachers at their school location. A few days later an email was sent to the teachers selected with a link to the survey website. The email also contained attachments of the informed consent form, the district approval letter, and a narrated PowerPoint that explained the procedure for setting up a confidential user ID and password to preserve anonymity, and for taking the survey. Once the teacher reviewed the email attachments, he or she clicked on the link to navigate to the survey login screen.

A second reminder email was sent two weeks after the initial contact. The final contact attempt was either a phone call or postcard to those who did not respond. Data were collected in two separate three week time frames: May 18, 2008 to May 31, 2008 and August 17, 2008 to September 6, 2008.

Dillman (2007) identified four sources of survey error: sampling error, coverage error, measurement error, and non-response error. The proportional stratified random sampling procedure adopted for this study reduced sampling and coverage error to an acceptable level (±3%) because all teachers had an equal or known chance of being selected (Dillman, 2007). Non-response error was reduced by using Dillman's (2007) four contact mixed mode method for the administration of the survey (i.e. pre-notice letter, questionnaire, thank you note, replacement questionnaire, final special contact in a different mode). A token incentive was included with the pre-notice letter. Token incentives given up front capitalize on what Social Exchange Theory suggests is an effective way to engage participants, and is a proven method for increasing survey response rates (Dillman, 2007).

Measurement error was reduced by using the LoTiQ survey. The LoTiQ format and item structure is based on the Concerns-Based Adoption Model (CBAM). CBAM is a Macro (Systemic Change) theory of diffusion in which change facilitators understand change from the point of view of the people who will be affected by that change. The idea of CBAM is to bring about systemic restructuring by understanding the social, political, and interpersonal aspects of the school (Hall & Loucks, 1979; Surry, 1997).

Data Analysis

Quantitative data was downloaded from the survey website, scored according to the guide, and imported into SPSS statistical software. Once downloaded, the data were kept on a computer that was independent of network access. This preserved participant confidentiality.

The data gathered from the LoTiQ Survey and the additional demographic questions were analyzed using descriptive statistics, multiple regression, and correlation. The results were compiled and presented using percentages and frequencies. Statistical calculations were completed using SPSS statistical software. Stepwise multiple regression analysis (MRA) was used to investigate the relationship between the independent variables Wireless Mobile Cart Access (WMCA), Teachers' Technology Proficiency/Efficacy (PCU), and Teachers' Current Instructional Practice (CIP), and overall Teachers' Current Level of Technology Implementation (C-LoTi) which is the dependent variable. Stepwise MRA helped to identify the best predictor of C-LoTi among the independent variables WMCA, CIP, and PCU. The relationship between the variables under investigation and research questions to items on the LoTiQ survey is presented in Table 1 which is also located in Chapter I (see pg 10).

Table 1

Relationship between Variables, Research Questions, and LoTiQ Survey Items.

Variable Name	Research Question	Items on LoTiQ	Method of Data Analysis
Independent Variable #1: Wireless Mobile Cart Access (WMCA)	Research Question #1: What is the level of teacher/student access to wireless mobile cart technology in the district? Research Question # 3: Does wireless mobile cart access relate to C-LoTi in the district?	Additional Demographic Questions: 7, 8, 9	RQ# 1: descriptive statistics (i.e. percentages & frequencies) RQ # 3: Stepwise Multiple Regression
Dependent Variable: Current Level of Technology Implementation (C-LoTi)	Research Question #2: What is C-LoTi in the district?	LoTiQ Questions: 1-5,7-12, 14, 16, 17,19, 21-25, 27-31, 33-40, & 42-48	RQ #2: descriptive statistics (i.e. percentages & frequencies)
Independent Variable #2: Teacher Technology Proficiency/Efficacy (PCU)	Research Question#4: What is the level of PCU? Research Question#5: Does the level of teacher PCU relate to C-LoTi?	LoTiQ Questions: 13,15, 18, 26, and 49 Additional Demographic Question: 10	RQ #4: descriptive statistics (i.e. percentages & frequencies) RQ #5: Stepwise Multiple Regression
Independent Variable #3: Teacher Current Instructional Practice (CIP)	Research Question #6: Is teacher-centered or learner-centered practice the more predominant CIP? Research Question #7: Is there a relationship between CIP and C-LoTi in the district?	LoTi Questions 6, 20, 32, 41, and 50	RQ #6: descriptive statistics (i.e. percentages & frequencies) RQ #7: Stepwise Multiple Regression

In addition, a correlation matrix was used to determine the strength and direction of the relationship as well as the level of statistical significance between each of the independent variables and the overall LoTi. Since the variables were continuous rather than categorical, the number of regressors was limited so that the ratio of ten observations to one independent variable was maintained. Observing this ratio was especially critical with continuous data because sample sizes are typically much smaller than sample sizes for categorical data (Bartlett, Kotrlik, & Higgins, 2001).

Participants selected a response to survey questions on a Likert-type scale from zero to seven that best represented their own perception of the degree to which that question applied to their performances, beliefs, and practices. Although many studies have generally established the usefulness of self-report data for measuring attitudes and perceptions because these are not directly observable, there are some limitations to self-report data. Major limitations include the possibility of the socially desirable response tendency as well as errors in recall (Gay & Arasian, 2000).

Qualitative data in the form of responses to the open ended demographic survey questions were downloaded from the survey website and imported into Center for Disease Control EZText (CDC-EZText) software for analysis. The data were coded, filtered, and categorized to identify dominant themes concerning access to the wireless mobile cart, actual use of the wireless mobile cart in the classroom, barriers to use of the wireless mobile cart, and amount of technology professional development in the prior year. The researcher reviewed and reported the significant patterns and themes that were identified and connected these to the literature (Patton, 2002).

Summary

The LoTiQ Survey was used to collect data from a sample of in-service teachers in a Southwestern urban school district (*n=83*), and these data were analyzed to investigate, and describe the effects of wireless mobile cart access on the level of teachers' technology implementation. The survey was administered in an online format to economize on time and personnel needed to collect data. Sampling and coverage error was minimized by the use of a proportional random sampling procedure. Non-response error was reduced by using Dillman's (2007) four contact mixed mode method for the administration of the survey. Measurement error was reduced by using the LoTiQ, a valid and reliable survey instrument with strong internal consistency for data collection.

Research questions were addressed by analyzing the data collected using descriptive statistics, and by applying a stepwise multiple regression procedure to investigate the relationship between the independent variables and overall LoTi level. Qualitative data were collected from additional open ended questions that were added to the LoTiQ survey. The qualitative data were analyzed to identify common themes concerning access and use of the wireless mobile cart, and professional development issues. Chapter IV presents all the findings in detail, and will be useful for administrators in developing professional development strategies to improve implementation levels, and in determining technology acquisitions.

CHAPTER IV - FINDINGS

Introduction

This chapter presents the results of the study to investigate the level of teachers' technology implementation following the deployment of the wireless mobile carts throughout a Southwestern urban school district. The data gathered from the LoTiQ survey instrument were analyzed using multiple regression and descriptive statistics, and are presented in a variety of formats that include tables, graphs, and narrative. SPSS statistical software was used to analyze quantitative data, and CDC-EZ text software was used to analyze qualitative data from the open ended demographic questions regarding barriers to technology use in the classroom, and amount of technology professional development that teachers had in the last year. Three independent variables (WMCA, PCU, and CIP), and one dependent variable (C-LoTi) were investigated using seven research questions. Table 1 in Chapter III – Methodology outlines the relationship between the variables, research questions, and LoTiQ survey items. The results for each variable and the associated research questions are presented.

Results for Independent Variable Wireless Mobile Cart Access (WMCA)

Research Question #1 and Research Question #3 were used to investigate the independent variable WMCA. Research Question #1 asked: What is the level of teacher and student access to wireless mobile cart technology in the district? Research Question #3 asked: Does wireless mobile cart access relate to C-LoTi in the district? In addition, Demographic Questions #6, 7, 8 and 9 were used to identify the barriers to teacher use of the wireless mobile cart. Table 12 shows that 90 percent of teachers reported that they had access to a wireless mobile cart in their building. Demographic Question 7 addressed this issue. Participants responded to the statement "I have access to a wireless mobile laptop cart in my building" by selecting one of three response categories on a scale from 0 to 7: 1-2 = not true now; 3-5 = somewhat true now; and 6-7 = very true now.

Table 12

Wireless Mobile Cart Access

Question: I have access to a wireless mobile laptop cart in my building.		
Response	# of Teachers	% of Teachers
Not true now	8	10%
Somewhat true now	20	25%
Very true now	53	65%

Questions 47 and 48 in the LoTiQ survey (Appendix A) investigated access to Internet-connected computers during the instructional day for teachers and students. Participants responded to question #48–("My students have immediate access to all forms of cutting-edge technology and computers at any time during the instructional day to pursue their authentic problem-solving surrounding an issue or problem of importance to them" by selecting one of three categories of responses on a scale from 0 to 7: (1-2 = not true now; 3-5 = somewhat true now; and 6-7 = very true now). Sixty-five percent of participants reported that their students did not have immediate access to Internet-connected computers throughout the instructional day.

This appears to contradict the finding that 90 percent of participants indicated they had access to computers in their school building. However, this finding was consistent with prior research, which identified that for the majority of students computer access was "one step outside of the classroom" – that is computers were more available in a lab setting rather than in the classroom (CDW Government Inc., 2006; McAdoo, 2005; National Center for Education Statistics, 2006; U.S. Department of Education Office of Educational Technology, 2004).

Although only 35 percent of participants reported that their students had immediate and unlimited access to Internet-connected computers for instructional use, 90 percent of participants indicated that they had access to computers in their school building.

In spite of the fact that 90 percent of participants reported they had access to the wireless mobile laptop cart, 60 percent of participants indicated that they never used the wireless mobile cart in the two years since the deployment of the carts. As shown in Table 13, 17 percent of participants used the wireless mobile cart once monthly, seven percent of participants used the wireless mobile cart once weekly, four percent of participants used the wireless mobile cart 2-3 times weekly, and ten percent of participants used the wireless mobile cart daily.

Table 13

Frequency of Wireless Mobile Laptop Cart Use

Question: I use the wireless mobile laptop cart for classroom instruction.		
Response	# of Teachers	% of Teachers
Never	49	60%
Once monthly	14	17%
Once weekly	7	9%
2-3 times weekly	3	4%
Daily	8	10%

Demographic Questions #6 and #9 (Appendix B) probed the teachers' perception of the barriers to technology use. Demographic Question #6 asked: What do you perceive as your greatest obstacle to further using technology in your instructional setting? Demographic Question #9 asked: What barriers do you need to overcome in order to use the wireless mobile laptop cart in your teaching practices? Sixty percent of teachers responding to Demographic Question # 6 regarding their perception of the greatest obstacle to technology use identified time to learn, practice, and plan, and lack of staff professional development/training as the greatest obstacle. Thirty percent of Demographic Question #6 respondents identified access to technology as the greatest obstacle. Table 14 summarizes the results from Demographic Question #6.

Table 14

Greatest Obstacles to Teachers Technology Use

Obstacle	# of Teachers	% of Teachers
Time to Learn, Practice, and Plan	45	56%
Access to Technology	25	30%
Other Priorities (e.g., Statewide Testing, New Textbook Adoptions)	9	11%
Lack of Staff Development Opportunities	3	4%

Demographic Question #9 (Appendix B) was an open ended question that probed teachers' perception of the barriers to using the wireless mobile laptop cart specifically. Verbatim responses were downloaded from the survey website and imported into CDC-EZText software for analysis. Several dominant themes emerged that were consistent with significant patterns and themes that were previously identified in the literature review in Chapter II. The majority of the themes (71 percent) fit into Category 1 – Systemic or Organization Barriers that include: (1) lack of technology access, (2) lack of information technology (IT) support, and (3) lack of time to plan and learn how to integrate computers into the lessons, and evaluate outcomes.

Twenty-two percent of the themes identified fit into Category 2 – Individual or Member Barriers that include: (1) Teacher technology efficacy and proficiency (i.e., teacher attitudes toward technology use and teacher confidence in his or her ability to use technology), (2) Teacher philosophy/practice (i.e., teacher instructional practice that ends toward a teacher-centered or student-centered method of teaching that impacts how technology is used).

Seven percent of respondents to Demographic Question #9 indicated that there were no barriers to using the wireless mobile laptop cart. However, all of the teachers that said there were no barriers also said they had desktop computers in their classrooms for the students to use.

Figure 5 shows the results of Demographic Question #9 and presents typical verbatim comments from the teachers that were classified as Category 1 or Category 2 type barriers.

Figure 5

Barriers to Use of Wireless Mobile Laptop Cart

Barrier	Major Theme	%Teachers	Typical Comments
Category 1: Systemic or Organizational (i.e. access; IT support; time to learn, practice, plan)	Access, availability (scheduling), not enough computers, inappropriate physical environment	36%	"don't like idea of not having enough laptops for each student"
			"not enough laptops working for class of 25 students"
			"Only one mobile cart per floor and scheduling is a big issue!"
			"trying to schedule around other teachers using the cart"
			"They are stored on a lower level and it is time consuming, tedious, and laborious to move them to my classroom"
			"The carts are too far away from my room, the stairs and long hallways make it very hard to move them from place to place"
			"limited classroom area to plug the cart into the outlets"
			"Annex teachers do not want to risk damaging the laptops".
Category 1	Time	20%	"time to plan on how to incorporate the computer use into my already very structured day"
			"not enough time to learn how to use the equipment with confidence"
			"more time to practice so I feel comfortable with using it as an educational tool"
Category 1	IT Support	15%	"IT support to keep the laptops working and updated"
			"We are on a wireless system that is very slow, if up at all"
Category 2: Individual Member (i.e. teacher efficacy/proficiency; teacher philosophy/practice)	Teacher training	13%	"I need additional training on the cart and probably some ideas on how to incorporate it into my classroom instruction"
			"I don't know what a wireless mobile laptop cart is."
			"Where is it and what do I do with it?"
Category 2	Teacher attitude	9%	"I have anxiety related to the use of technology. I have a fear that I will break it or be unable to get it to work"
			"fear of teaching lessons using technology because of my lack of experience doing so"
			"I have no use for them";
No Barrier	No Barrier	7%	"The students have desktops."; "I have several PC computers in my classroom for the students."

Results for Independent Variable PCU

Research Question # 4 and Research Question #5 were used to investigate teachers' technology proficiency/efficacy (PCU). Demographic Question #10 provided additional information regarding the amount of teacher technology professional development may impact teacher technology proficiency/efficacy. Research Question # 4 asked: What is the level of teacher technology proficiency/efficacy (PCU)? Research Question # 5 asked: Does the level of teacher PCU relate to C-LoTi? The PCU profile addressed each participant's comfort and proficiency level with using computers. This included troubleshooting simple hardware problems as well as using multimedia applications at home or in the workplace. The PCU profile was compiled based on participants' responses to LoTiQ questions 13, 15, 18, 26, and 49 (Appendix A) on a scale of 0 to 7: (1-2 = not true now; 3-5 = somewhat true now; and 6-7 = very true now).

PCU was used in this study as the measure for teacher technology proficiency/efficacy. Table 15 displays the perceptions of participants toward questions 13, 15, 18, 26, and 49 involving their personal computer use.

Table 15

District Personal Computer Use (PCU) Intensity Levels

PCU Intensity Level	# of Teachers	% of Teachers
Level 0	1	1%
Level 1	0	0%
Level 2	6	7%
Level 3	15	18%
Level 4	17	20%
Level 5	14	17%
Level 6	21	25%
Level 7	9	11%
Median PCU Score: PCU Intensity Level 5 (Somewhat True of Me Now) *Mode PCU Score:* PCU Intensity Level 6 (Very True of Me Now)		
Intensity Levels Legend		
Level 0 - Level 2: Not True of Me Now *Level 3 - Level 5:* Somewhat True of Me Now *Level 6 - Level 7:* Very True of Me Now		

Based on participant responses, the median PCU Level for the District corresponded with a PCU Intensity Level 5 (Somewhat True of Me Now). A PCU Intensity Level 5 indicates that the participant demonstrates high skill level with using computers for personal use. Participants at Intensity Level 5 are commonly able to use the computer to create their own web pages, produce sophisticated multimedia products, and/or effortlessly use common productivity applications (e.g. Microsoft Excel, FileMaker Pro), desktop publishing software, and web-based tools. They are also able to confidently troubleshoot most hardware, software, and/or peripheral problems without assistance from technology support staff (Learning Quest Inc., 2008). Seventy-three percent of teachers were clustered in the higher PCU Intensity Levels 4-7.

Demographic Question #10 (Appendix B) asked teachers about the amount of technology professional development they received in the previous year. Teachers must invest a substantial amount of time to overcome the fear of using new technology and to redesign teaching strategy to integrate that technology. (Brown, 2004; Lancaster, 2000). The results revealed that 80 percent of teachers had ten or less hours of technology professional development in the previous year, and only ten percent had 21 or more hours. Table 16 summarizes the result from Demographic Question #10.

Table 16

Number of Hours of Technology Professional Development in the Last Year

Response	# of Teachers	% of Teachers
5 or less hours	42	50%
6-10 hours	25	30%
11-15 hours	4	5%
16-20 hours	5	6%
21 or more hours	8	10%

Results for Independent Variable CIP

Research Question #6 and Research Question #7 were used to investigate teachers' Current Instructional Practices (CIP). Research Question #6 asked: Is teacher-centered or learner-centered practice the more predominant Current Instructional Practice (CIP)? Research Question #7 asked: Is there a relationship between CIP and C-LoTi in the district? The CIP profile revealed each participant's support for or implementation of instructional practices consistent with a learner-based curriculum design (e.g., learning materials determined by the problem areas under investigation, multiple assessment strategies integrated authentically throughout the curriculum, teacher as co-learner/facilitator, focus on learner-based questions). The CIP profile was compiled based on teacher's responses to LoTiQ questions 6, 20, 32, 41, and 50 (Appendix A) on a scale of 0 to 7: 1-2 = not true now; 3-5 = somewhat true now; and 6-7 = very true now.

Table 17 presents the perceptions of teachers toward questions 6, 20, 32, 41, and 50 concerning their current instructional practices.

Table 17

District Teachers Current Instructional Practices (CIP) Intensity Levels

CIP Intensity Level	# of Teachers	% of Teachers
Level 0	5	6%
Level 1	6	7%
Level 2	12	14%
Level 3	14	17%
Level 4	22	27%
Level 5	16	19%
Level 6	8	10%
Level 7	0	0%
Median CIP Score: CIP Intensity Level 4 (Somewhat True of Me Now) *Mode CIP Score:* CIP Intensity Level 4 (Somewhat True of Me Now)		
Intensity Levels Legend		
Level 0 - Level 2: Not True of Me Now *Level 3 - Level 5:* Somewhat True of Me Now *Level 6 - Level 7:* Very True of Me Now		

Based on teachers' responses, the median CIP level for the District corresponded with a CIP Intensity Level 4 (Somewhat True of Me Now). At a CIP Intensity Level 4, the participant may feel comfortable supporting or implementing either a subject-matter or learning-based approach to instruction based on the content being addressed. In a subject-matter based approach, learning activities tend to be sequential, student projects tend to be uniform for all students, the use of lectures and/or teacher-directed presentations are the norm as well as traditional evaluation strategies. In a learner-based approach, learning activities are diversified and based mostly on student questions, the teacher serves more as a co-learner or facilitator in the classroom, student projects are primarily student–directed, and the use of alternative assessment strategies including performance-based assessments, peer reviews, and student reflections are the norm (Learning Quest Inc., 2008). Sixty-three percent of teachers were clustered at CIP Intensity Levels 3, 4, and 5.

Results for Dependent Variable C-LoTi

Research Question #2 was used to investigate the Dependent Variable C-LoTi. Research Question #2 asked: What is the current level of technology implementation (C-LoTi) in the district? The LoTi framework consists of eight levels ranging from 0 (Non-Use) to 6 (Refinement). Level 4 is divided into two levels: 4a (Integration-Mechanical) and 4b (Integration-Routine). The LoTi framework was used to classify the level of in-service teacher technology implementation based on the results of the LoTiQ survey. LoTiQ questions 1-5, 7-12, 14, 16, 17, 19, 21-25, 27-31, 33-40, & 42-48 (Appendix A) were used to determine the overall LoTi level of teachers. Although 90 percent of participating teachers reported having instructional access to computers for teacher and student use, approximately 55 percent were clustered in LoTi Levels 0 (Non-Use) through 2 (Exploration). These levels represent the lower portion of the LoTi framework and focus primarily on teachers' use of productivity tools, student use of tutorial programs, and "project-based" learning opportunities at the knowledge/comprehension level. Thirty-six percent of participants were clustered in Level 3 (Infusion) and Level 4a (Integration – Mechanical). Levels 3 and 4a are characterized by teacher and student use of tool based applications and externally developed technology resources. At the 3 and 4a LoTi Levels, teachers begin to develop challenging learning experiences; however, learning opportunities focus primarily on knowledge/comprehension with some application level.

Level 4b (Integration – Routine) is identified as the Target Technology Level as defined by the National Education Technology Standards (NETS) and Technology Standards for School Administrators (TSSA). This level is characterized by technology use embedded in challenging and engaging learning experiences that promote problem-solving, critical thinking, and self-directed learning (Moersch, 2002). Only eight percent of participants assessed themselves at the Target Technology Level or above.

Table 18 shows how participants were distributed in the various levels of the LoTi framework.

Table 18

Current District Level of Technology Implementation (C-LoTi)

C-LoTi	LoTi Level Description	# of Teachers	% of Teachers
0 Non Use	There is no visible evidence of computer access or instructional use of computers in the classroom.	14	17%
1 Awareness	Available classroom computer(s) are used primarily for teacher productivity (e.g., email, word processing, grading programs).	17	20%
2 Exploration	Student technology projects (e.g., designing web pages, research via the Internet, creating multimedia presentations) focus on the content under investigation.	15	18%
3 Infusion	Tool-based applications (e.g., graphing, concept-mapping) are primarily used by students for analyzing data, making inferences, and drawing conclusions.	19	23%
4a Integration (Mechanical)	The use of outside resources and/or interventions aid the teacher in developing challenging learning experiences using available classroom computers.	11	13%
4b Integration (Routine)	Teachers can readily design learning experiences with no outside assistance that empowers students to identify and solve authentic problems using technology.	4	5%
5 Expansion	Teachers actively elicit technology from outside entities to expand student experiences directed at problem-solving, issues resolution, and student action.	3	4%
6 Refinement	Computers provide a seamless and almost transparent medium for information queries, problem-solving, and/or product development	0	0%
Target Technology Level	Participants indicating they implement technology in their respective classrooms at the Target Technology Level (LoTi Level 4b) or above.	7	8%

Results from Multiple Regression Analysis

Does WMCA, PCU, and CIP relate to the current level of technology implementation (C-LoTi) in the district? Table 1 *Relationship Between Variables, Questions, & LoTiQ Survey Items* in Chapter III – Methods (see page 82) outlines the dependent and independent variables, research questions and the specific LoTiQ survey items and demographic questions that related to variable measurement.

SPSS statistical software was used to conduct stepwise multiple regression analysis (MRA) to investigate the relationship between the independent variables WMCA, PCU, and CIP and the dependent variable C-LoTi. MRA is an appropriate statistical method for studying the relation between a dependent variable and two or more independent variables. The sample for this study (*N=83*) met the design requirements for MRA because it exceeded the required minimum of 50 cases and 10 times more cases than independent variables (Shavelson, 1996).

The magnitude of the relationship between the dependent variable C-LoTi and the combination of the independent variables WMCA, PCU, and CIP was estimated by the multiple correlation coefficient (R). The proportion of variance in C-LoTi that was accounted for by related variance in the independent variables WMCA, PCU, and CIP was measured by the coefficient of determination (R^2). Table 19 presents the MRA models generated by SPSS. Model 2 entered both the CIP and PCU variables into the regression model and indicated that 37 percent of the variance in the dependent variable (C-LoTi) was accounted for by related variance in the independent variables CIP and PCU. The independent variable WMCA did not make a useful contribution to the regression model.

Table 19

Regression and Correlation Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.571(a)	.326	.318	1.21316
2	.605(b)	.366	.350	1.18419

a Predictors: (Constant), CIP
b Predictors: (Constant), CIP, PCU
c Dependent Variable: C-LoTi

The independent variables CIP and PCU had statistically significant relationships with the dependent variable C-LoTi. The independent variable WMCA had a statistically significant but weak correlation to C-LoTi. Table 20 displays the Beta coefficients for CIP and PCU.

Table 20

Beta Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.382	.313		1.219	.227
	CIP	.512	.082	.571	6.264	.000
2	(Constant)	-.294	.430		-.685	.496
	CIP	.436	.087	.486	5.028	.000
	PCU	.203	.091	.217	2.239	.028

a Dependent Variable: LOTI

Table 21 is the Pearson correlation matrix calculated in SPSS that shows the direction and strength of relationship between all of the variables under investigation, both independent and dependent. These correlations clarify and support the data from the regression analysis.

Table 21

Correlation Matrix for All Variables

		LOTI	WMCA	PCU	CIP
Pearson Correlation	LOTI	1.000	.194	.407	.571
	WMCA	.194	1.000	.063	.137
	PCU	.407	.063	1.000	.392
	CIP	.571	.137	.392	1.000
Sig. (1-tailed)	LOTI	.	.039	.000	.000
	WMCA	.039	.	.287	.109
	PCU	.000	.287	.	.000
	CIP	.000	.109	.000	.

Stepwise multiple regression analysis confirmed that (CIP) had the strongest relationship to and prediction of LoTi level. There was a statistically significant positive relationship (r=.571) which indicated that as CIP increased the Level of Technology Implementation increased. The Beta (b) coefficient was .571 ($p<0.05$), accounting for 33 percent (r^2) of the variance in the LoTi level. This finding was consistent with prior research demonstrating that instructional practices that tend to be more student-centered are strongly tied to higher levels of technology implementation (Dwyer, 1994; McAdoo, 2005; Schechter, 2000; Stoltzfus, 2005).

Personal Computer Use (PCU) also had a statistically significant positive relationship the Current LoTi level. The Beta coefficient was .217 ($p<0.05$) and the Pearson correlation was .407, which indicated that as PCU increased the

LoTi level increased. PCU accounted for four percent (r^2) of the variance in the Current Level of Technology Implementation.

WMCA had a small correlation to C-LoTi. The WMCA variable Pearson correlation was .194. Wireless Mobile Cart Access accounted for zero percent (r^2) of the variance in the Current Level of Technology Implementation. Collectively CIP and PCU accounted for 37 percent of the variance in C-LoTi. Conversely 63 percent of the variance in C-LoTi was not explained by CIP and PCU and were therefore related to other factors. Additional demographic questions that were added to the LoTiQ Survey provided a means for probing further into other factors that potentially had an effect on teachers' Level of Technology Implementation.

Summary

This study focused on determining the level of technology implementation (LoTi) in a U.S. Southwestern Urban School District following a multimillion dollar Wireless Mobile Laptop Cart deployment. Eighty-three in-service teachers participated in this study by completing an online survey (Levels of Technology Implementation – LoTiQ) developed by Moersch (1995). The LoTi framework is grounded in (Rogers, 1995) Diffusion of Innovations Theory and established the means for measuring teacher technology use in classroom instruction. Results showed that although 90 percent of teachers reported having access to the wireless mobile cart, 60 percent indicated that they never used them. In spite of the fact that 90 percent of teachers said they had access to computers somewhere in the school during the day, 55 percent of teachers were clustered at the lowest LoTi levels.

The key factors of WMCA, PCU, and CIP that can influence the level of technology implementation in classroom instruction were identified and analyzed with correlation and multiple regression to determine if there was a statistically significant relationship between these factors and the LoTi level.

CIP and PCU were found to have moderate relationships with LoTi levels. Although there was only a weak relationship between WMCA and LoTi Level, several barriers to Wireless Mobile Cart use were identified through qualitative questions.

Chapter V presents the conclusions, and interpretation of the results, along with a discussion of the limitations and implications of the study. Recommendations for further study and recommendations for technology leaders are also discussed.

CHAPTER V - CONCLUSIONS

Introduction

The Southwestern urban school district that was the site for this study was the recipient of a historic tax initiative voted in by the citizens of the metropolitan area in 2001 that allocated $52 million for computer technology. Approximately $4 million dollars was spent on the acquisition and deployment of wireless mobile laptop carts in 2006 and in 2007 to provide additional Internet-connected computer access for students. Ninety percent of district teachers and students now have access to wireless laptop computers in their school sites.

In spite of the large technology expenditures, and increased teacher and student access to Internet-connected computers, many teachers were not maximizing the use of that technology for teaching and learning. The Southwestern urban school district did not have information on the types or extent of teacher technology use, the effectiveness of teacher technology use, or the reasons for teacher non-use of the wireless mobile cart. As a result, district technology leaders could not determine the most effective means for encouraging teacher adoption of the wireless mobile cart which would maximize the district's investment. In addition, technology leaders could not provide researched based data related to the effectiveness of technology instructional interventions that are a reporting requirement in connection with the expenditures of federal and state funds.

Teachers are the all important key to maximizing the use of the enormous amounts of costly technology resources that are now available (Trotter, 2007). In order to encourage the adoption of that technology for teaching and learning, technology leaders must first have a framework for thinking about the appropriate use of technology, and have a reliable way to measure effective use. The LoTi framework and the LoTiQ survey that was used in this research are valid and reliable tools for thinking about and for measuring the levels of teacher technology implementation (McAdoo, 2005; Moersch, 1996; Schechter, 2000; Stoltzfus, 2005).

The purpose of this study was to provide technology leaders in the Southwestern urban school district with data that can be used to guide future technology acquisition initiatives, and that would also give substantive information for developing appropriate and effective technology professional development opportunities for teachers.

Seven research questions were used to investigate the variables (WMCA, PCU, CIP, and C-LoTi). Table 1 in chapter III – Methodology (see page 82) shows the relationship between the variables, research questions, and the LoTiQ survey items. Eighty-three in-service teachers took the LoTiQ survey online. The data gathered from the LoTiQ were analyzed using multiple regression and descriptive statistics. Results were presented in a variety of formats that included tables, graphs, and narrative.

Interpretation of Results for Independent Variable

Wireless Mobile Cart Access (WMCA)

Research Questions # 1 and Research Question #3 investigated the independent variable WMCA, probed the issue of teacher and student access to the wireless mobile laptop cart, and the relationship of access to the levels of teacher technology implementation. Research Question # 1 asked: What is the level of teacher and student access to wireless mobile cart technology in the district? Research Question #3 asked: Does wireless mobile cart access relate to C-LoTi in the district?

Ninety percent of participants reported that they had access to the wireless mobile laptop cart, yet only 40 percent indicated that they used the cart (17 percent used monthly, 7 percent used once weekly, 4 percent used 2-3 times weekly, and ten percent used daily). Sixty percent of teachers indicated that they never used the wireless mobile cart in the two years since the deployment of the carts. Although 90 percent of teachers reported that they had access to computers for teacher and student instructional use, only 35 percent said that they had *immediate* access to Internet-connected computers throughout the instructional day. On the surface this appears to be a contradiction, however an examination of the qualitative questions that probed barriers to use uncovered that although Internet-connected computer access may be nearly universal, that technology may not be easily accessible.

The majority of computers in most of this district's schools were usually placed in labs rather than in the classroom. The wireless mobile carts were designed to overcome the issue of computer access being in labs. Computer access that is confined to a lab has been described as having access that is "one step outside of the classroom" (U.S. Department of Education Office of Educational Technology, 2004). In spite of the wireless mobile cart availability, 60 percent of teachers were not using the wireless mobile carts. Verbatim comments regarding barriers to using the wireless mobile cart uncovered the fact that the majority of non-use (71 percent) was due to Category 1 - Systemic or Organizational Barriers. Thirty-six percent (36 percent) of teachers said non-use barriers were: (a) not having enough computers for all students, (b) scheduling issues, (c) or that the location of their classroom made moving the wireless mobile carts extremely difficult if not impossible.

Thirty-five percent (35 percent) of teachers also indicated that non-use of the wireless mobile cart was due to the lack of time to learn, practice, and the lack of IT support to keep the network and computers functioning. In this study wireless mobile cart access (WMCA) had a statistically significant but weak relationship to teachers' level of technology implementation (C-LoTi). The barriers identified may possibly have had some influence on that result. It is interesting to note that all of the 7 percent of teachers who indicated that there were no barriers also said that they had computers in their classroom for students to use.

In order to encourage teachers' adoption of the wireless mobile cart innovation, district technology leaders should identify and address the common and site specific Category 1 – Systemic/Organizational barriers that prevent teachers from successfully using the wireless mobile laptop Cart.

Interpretation of Results for Independent Variable

Personal Computer Use (PCU)

Research Questions #4 and Research Questions #5 were used to investigate teachers' technology proficiency/efficacy as reflected by the personal computer use (PCU) measurement. Research Question #4 asked: What is the level of teacher technology proficiency/efficacy (PCU)? Research Question #5 asked: Does the level of teacher PCU relate to C-LoTi?

Seventy-three percent of teachers were clustered in the higher intensity levels (4-7) of PCU. This finding indicated that the majority of district teachers were sufficiently proficient with using computers. This proficiency included using multimedia applications, common productivity applications, and troubleshooting simple software or hardware problems without technology support staff.

PCU had a moderate and statistically significant relationship with the Current Level of Technology Implementation (C-LoTi). PCU accounted for 4 percent of the variance in the C-LoTi Level. Based on the results, an increase in teachers' PCU level would have only a moderate effect on teachers' LoTi level. It follows that professional development that has a main goal of increasing teachers' technology proficiency would have only a moderate impact on teachers' level of technology integration.

Interpretation of Results for Independent Variable Current Instructional Practice (CIP)

Research Questions #6 and Research Question #7 explored the level of teachers' current instructional practice (CIP) that identified the degree to which teachers used learner-centered practices. Research Question #6 asked: Is teacher-centered or learner-centered practice the more predominant Current Instructional Practice (CIP)? Research Question #7 asked: Is there a relationship between CIP and C-LoTi in the district?

Sixty-three percent of teachers were clustered in the higher intensity levels (3-7) of CIP. This means that the majority of district teachers had learner-centered instructional practices. CIP had a strong and statistically significant positive relationship with C-LoTi. CIP was the strongest predictor, accounting for 33 percent of the variance in the C-LoTi Level. Prior research consistently identified that instructional practices that tend to be more student centered were strongly tied to higher levels of technology implementation (Dwyer, 1994; McAdoo, 2005; Schechter, 2000; Stoltzfus, 2005). Because of the strong correlation to LoTi Level, CIP and PCU dimensions provide a way for technology leaders to identify the best candidates for professional development which provides concrete training on ways to use technology to create engaging learning experiences for students that promote problem-solving, critical thinking, and self-directed learning. Research shows that exemplary technology using teachers provide learning opportunities that target higher levels of learning (i.e. analysis, synthesis, and evaluation) (Bae, 2006; Bigatel, 2004). Teachers with high PCU and CIP Intensities that were operating on the Lower LoTi levels would respond most favorably to Category 1 - Systemic/Organizational barrier removal efforts and increased time for appropriate professional development activities.

Interpretation of Results for Dependent Variable Current Level of Technology Implementation (C-LoTi)

Research Question #2 investigated the dependent variable Current Level of Teachers' Technology Implementation (C-LoTi). Research Question #2 asked: What is the current level of technology implementation (C-LoTi) in the district? Fifty-five percent of teachers were clustered in LoTi Levels 0 (Non-Use) through 2 (Exploration) which is the lower portion of the LoTi framework. At these levels, teachers focus primarily on using productivity tools and on student use of tutorial programs that target learning at the knowledge/comprehension level. This means that the majority of district teachers were not maximizing the use of technology in spite of the fact that 90 percent had access to Wireless Mobile Cart Technology. PCU and CIP only accounted for 37 percent of the variance in C-LoTi. Therefore, 63 percent of the variance in C-LoTi was not explained by CIP and PCU and was consequently related to other factors.

Discussion of Limitations and Implications

The results of this study were derived from data collected with an online self-report survey. The data was not triangulated with classroom observations, interviews, or document analysis. Caution must be taken in interpreting and applying the findings (Patton, 2002). However, it is teachers' perceptions and attitudes that drive the use or non-use of educational technology in the classroom. Although perceptions and attitudes might have observable outward behaviors, the evaluation of perceptions and attitudes can only be measured through self-report (Segrin & Flora, 2005). Qualitative approaches could potentially lead to a richer and deeper understanding of the research context; however, no approach provides full comprehension of a site and its inhabitants. Regardless of the number of variables that are studied, there are always others that were not examined (Gay & Arasian, 2000). In this study 63 percent of the variance in the dependent variable (C- LoTi) could be explained by variables not identified and examined by this research. Future studies using the LoTiQ could include an analysis of demographic and environmental variables, as well as variables related to school organization and culture.

The response rate for this research was somewhat lower than anticipated. This was a threat to the validity of the results and could diminish applicability to the general population under investigation.

Recommendations for Future Research

1. Investigate the relationship between Levels of Technology Implementation (LoTi) and student achievement as measured by state achievement tests.
2. Conduct a mixed methods study that will use classroom observation and document analysis to validate teacher self-reported data gathered from the LoTiQ.

3. Conduct a scientific study with a pre-test/ post-test design using the LoTiQ to measure the effect of a specific technology professional development program.

4. Investigate the relationship between teacher philosophy using the Philosophies Held by Instructors of Lifelong-learners (PHIL) instrument and the Levels of technology implementation using the LoTiQ instrument.

Recommendations for Technology Leaders

Technology leaders in this Southwestern urban school district have the daunting task of encouraging teacher adoption of educational technology innovations, providing IT support, and developing effective technology professional development. The following are recommendations that were derived from this research:

1. Consolidate technology instruction and in-services into a single development program based on the LoTi or a similar technology implementation framework. This would enable participants to visualize the symbolic relationship among instruction, assessment, and technology implementation. Simply knowing how to use a specific technology application does not automatically push a teacher to a higher level of technology use. Currently 55 percent of the participants self-assessed themselves at LoTi Level 0-2, yet 63 percent of these same participants indicated that they were implementing one or more of the attributes of a learner-centered curriculum. Professional

development should focus on helping teachers to make better connections between technology use and student authentic problem-solving in the classroom. Moving teachers to a higher level of technology implementation requires a personal commitment to changing one's paradigm about existing instruction and assessment practices (Learning Quest, 2008). It is critical in this process to avoid pedagogical dogmatism that insists on the transformation of student and teacher roles.

2. Address Category 1 – Systemic or Organizational Barriers. It is critical to avoid individual-blame bias – that is the tendency to hold an individual responsible for his or her problems, rather than the system of which the individual is a part (Rogers, 2003). Seventy-one percent of the barriers teachers identified were systemic or organizational, and only 22 percent of the barriers were related to teacher attitudes. Improving access, correcting environmental problems in the classroom, and providing enough laptops for a class of 25 or more students would contribute to increased technology use among the teachers that were clustered at the higher intensity levels of PCU and CIP. These teachers had the preconditions to function at higher levels of technology implementation but were not able to function at the higher levels due to Category 1 -Systemic /Organizational barriers. In addition, these teachers would benefit most from professional development that models specific techniques for integrating higher-

order thinking skills with the available classroom computers using tool-based applications (e.g. spreadsheets, graphs, multimedia, databases, concept-mapping, Internet tools)(Learning Quest, 2008).

3. Strengthen IT support structure. Fifteen percent of participants responding to the questions concerning barriers to wireless mobile laptop cart use indicated that there were problems with keeping the laptops updated and working, as well as problems with getting onto the wireless system. A strengthened IT support structure would reduce response time for resolving hardware and software issues. This may involve creating a cohesive learning collective. The learning collective functions to provide an additional way to identify and resolve technology use problems and provide just-in-time training (Whitaker & Coste, 2002).

Conclusions

The development and deployment of Internet-connected computer technology has driven major changes in American society and in most countries worldwide. It has changed the way we do business every day on a fundamental level. It is now commonplace to bank, shop, and date on the Internet. It is not unusual for surgical operations to take place while the surgeon is thousands of miles from the patient. We have instantaneous voice and image transmission from one end of the globe to another, and news is disseminated in seconds. The diffusion of the Internet is one of the most rapid and extensive of any advanced technology in history (Lunn & Suman, 2008; Wolcott & Goodman, 2003). From

1989 to 2002, 71 percent of adult Americans became Internet users (Rogers, 2003).

The technology-driven changes in American society as a whole are now apparent in K-12 education nationwide. Schools are moving from chalkboards to SmartBoards®, and from PowerPoint to podcasting. Since Congress authorized the federal “education rate” (E-rate) program in the Telecommunications Act of 1996, approximately $2 billion dollars annually in subsidies have been given to schools to support the cost of telecommunications services and access to the Internet (Trotter, 2007). In addition, *NCLB Title II, Part D – Enhancing Education Through Technology* appropriated $1 billion each year for five years through 2007 to carry out subparts one and two, which provided for state and local technology grants, and supported national technology activities *(No Child Left Behind Act of 2001, 2002*).

School districts also allocated billions to purchase and maintain educational technology. The Southwestern urban school district that was the site for this study spent $4 million dollars on the acquisition and deployment of wireless mobile laptop carts in 2006 and in 2007 to provide additional Internet-connected computer access for students. Since the majority of technology funds are publicly derived, there is a growing trend to assess teachers’ technology use in the classroom to satisfy the more stringent measures for accountability and evaluation of federally funded programs, and formula-based competitive grants (Moersch, 2002). This study contributed to the body of educational technology literature that examined K-12 in-service teacher’s technology use in the classroom, and provided researched-based data to satisfy accountability requirements for public funds expenditures.

Analysis of the data revealed that 90 percent of teachers in this district had access to the wireless mobile cart, but only 40 percent of teachers used the cart. The barriers that teachers identified were primarily Category 1 – Systemic/Organizational and proved to be the major reason that 60 percent of teachers had never used the wireless mobile laptop cart. Not having enough laptop computers for all students, scheduling conflicts, and classroom environment issues were frequently identified by teachers as reasons for non-use. In addition, 60 percent of teachers identified time to learn, practice, and plan as the greatest barrier to technology use. The barriers identified by teachers to wireless mobile cart use were more important to explaining non-use than access or lack of technology proficiency. Seventy-one percent of these barriers were related to Category 1 – Systemic/Organizational issues while only 22 percent were related to teacher attitudes.

Seventy-three percent of teachers were clustered in the higher intensity levels of Personal Computer Use (PCU) and 63 percent of teachers were clustered at the higher intensity levels of Current Instructional Practice (CIP). There was a strong positive correlation between CIP and PCU and the LoTi Level. Therefore, variances in CIP and PCU provide explanation for 37 percent of the variance in the LoTi Level. This means that the majority of teachers in this district had sufficient computer skills, and engaged in instructional practices that were prerequisites for performing at higher levels of technology implementation.

However, the majority of teachers were clustered at the lower levels of technology implementation.

Technology leaders should review existing professional development programs in light of the results from this study Teachers with high CIP and PCU would respond most favorably to Category 1 – Systemic/Organizational barrier removal and appropriate professional development. The focus should be on strategies that will move teachers to a higher level, and toward the target technology level of 4a.

The millions spent by the Southwestern urban school district to place wireless mobile carts in each building was a vital first step to increasing teacher technology implementation. However, it is important for technology leaders to be aware that access and ease of access are very different. The majority of the barriers to teachers' use of the wireless mobile carts that were identified in this study were mostly Category 1 – Systemic/Organizational. Systemic barrier removal must be addressed on a site level basis to be effective. This would increase teachers' use of the wireless mobile carts and would maximize the district's multi-million dollar investment.

REFERENCES

Alliance for Childhood. (2000). *Children and computers: A call for action.* Retrieved July 23, 2008 from http://www.allianceforchildhood.net/projects/computers/computers_articles_call_for_action.htm

Anderson, T., Varnhagen, S., & Campbell, K. (1998). Faculty adoption of teaching and learning technologies: Contrasting earlier adopters and mainstream faculty. *The Canadian Journal of Higher Education, 28*(23), 71-78.

Bae, Y. M. (2006). *Fostering higher order thinking in a technology-rich classroom environment: Learning from an exemplary middle school social studies teacher.* Unpublished Doctoral Dissertation, University of Texas, Austin.

Bartlett, J. E., II, Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning and Performance Journal, 19*(1), 8.

Becker, H. J., & Ravitz, J. L. (2001). *Computer use by teachers: Are Cuban's predictions correct?* Paper presented at the Annual Meeting of the American Educational Research Association. Retrieved August 15, 2008 from http://www.crito.uci.edu/tlc/findings/conferences-pdf/aera_2001.pdf

Bigatel, P. M. (2004). *Exploring the beliefs and attitudes of exemplary technology-using teachers.* Unpublished Doctoral Dissertation, Pennsylvania State University, Harrisburg.

Blankenship, S. E. (1998). *Factors related to computer use by teachers in classroom instruction.* Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University.

Bonk, C. (2001). The pedagogical TICKIT: Researching different online instructional methods [PowerPoint Presentation]. Retrieved July 19, 2008, from www.trainingshare.com/download/korea_new/pedagogical_TICKIT.ppt

Brown, J. (2004). *A multimethodological study of teachers' perceptions of technology professional development.* Unpublished Doctoral Dissertation, Western Michigan University, Kalamazoo.

Carter, C. W. (1998). *An assessment of the status of the diffusion and adoption of computer-based technology in appalachian college association colleges and universities.* Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University.

Caruthers, B. (2008). *Tying technology to test scores: Geary public schools technology case project*. Paper presented at the OK-Acts Winter Institute, Norman, OK.

CDW Government Inc. (2006). 4th annual teachers talk tech survey. Retrieved January 3, 2008, from http://newsroom.cdwg.com/features/feature-06-26-06.html

Collaborative for Technology Standards for School Administrators (TSSA Collaborative). (2006). *Technology standards for school administrators*. Paper presented at the TSSA Collaborative, Kalamazoo, MI. Retrieved May 5, 2006, from http://www.ncrtec.org/pd/tssa/tssa.pdf.

Creswell, J. W. (2003). *Research Design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks: Sage Publications.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge: Harvard University Press.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Diem, R. (2000). A look at student outcomes: A social studies/technology research project. Retrieved July 26, 2008, from University of Texas at San Antonio Web site: http://www.teacherlink.org/content/social/impact/impact_2000_1.htm

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method*. Hoboken: John Wiley & Sons, Inc.

Dwyer, D. (1994). Apple classrooms of tomorrow: What we've learned. *Educational Leadership*, 51(7), 4-10.

Education Week. (2008). Detailed state reports [Electronic Version]. *Technology Counts*, 27(30). Retrieved July 23, 2008 from http://www.edweek.org/ew/articles/2008/03/27/30dsr.h27.html.

Fichman, R. G. (1999). The diffusion and assimilation of information technology innovations. Retrieved May 20, 2007 from Boston College, Wallace E. Carroll School of Management Web site: http://www.bc.edu/~fichman/Fichman_2000_IT_Diff_chp.pdfw

Fisher, R. (1993). Social desirability bias and the validity of indirect questioning. *Journal of Consumer Research, 20*(2), 303.

Gay, L. R., & Arasian, P. (2000). *Educational research: Competencies for analysis and application* (6th ed.). Upper Saddle River: Prentice Hall.

Goddard, R. D., Hoy, W. K., & Wolfolk-Hoy, A (2000). Collective teacher efficacy: Its meaning, measure, and effect on student achievement. *American Education Research Journal, 33*(6), 479-507.

Hall, G., & Loucks, S. (1979). *Implementing innovations in schools: A concerns-based approach.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA. Retrieved August 10, 2008 from http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/2e/32/63.pdf

Hannafin, R. D., & Savenye, W. C. (1993). Technology in the classroom: The teacher's new role and resistance to it. *Educational Technology, 33*(6), 26-31.

Harris, J. (2005). Our agenda for technology integration: It's time to choose. *Contemporary Issues in Technology and Teacher Education, 5*(2), 116-122.

Hill, R. (1998). What sample size is "enough" in internet survey research? [Electronic Version]. *International Computing and Technology: An Electronic Journal for the 21st Century*, *6*. Retrieved October 4, 2008 from http://www.emoderators.com/ipct-j/1998/n3-4/hill.html

Hu, W. (2007). Seeing no progress, some schools drop laptops [Electronic Version]. *The New York Times*. Retrieved July 26, 2008 from http://www.nytimes.com/2007/05/04/education/04laptop.html/partner/rssnyt?_r=1&oref=slogin.

ies National Center for Education Statistics. (2006). *Computer and internet use by children and adolescents: 2003.* Retrieved from http://nces.ed.gov/fastfacts

International Society for Technology in Education. (2007). National educational technology standards and performance indicators for students (NETS-S) [Electronic Version]. Retrieved July 20, 2008, from http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/2007Standards/NETS_for_Students_2007_Standards.pdf

Isleem, M. I. (2003). *Relationships of selected factors and the level of computer use for instructional purposes by technology education teachers in Ohio public schools: a statewide survey.* Unpublished Doctoral Dissertation, Ohio State University.

Lam, Y. (2000). Technophilia vs. technophobia: A preliminary look at why second-language teachers do or do not use technology in their classrooms. *Canadian Modern Language Review,* 56(3), 390-420.

Lancaster, M. (2000). *A study of the extent and nature of computer use in Saskatchewan high school accounting instruction, and some of the factors that influence computer use.* Unpublished Masters Thesis, University of Regina, Regina.

Larson, L. (2003). A descriptive study of technology integration and faculty professional development in one higher education institution. *Dissertation Abstracts International, 64/01, 118. (AAT 3077736).*

Learning Point Associates. (2007). Understanding the no child left behind act of 2001: Technology integration. Retrieved September 9, 2007, from http://www.learningpt.org/QuickKeys

Learning Quest. (2008). LoTi recommendations. Retrieved September 27, 2008: http://www.loticonnection.com

Learning Quest Inc. (2008). Technology use profile frameworks. Retrieved August 1, 2008: http://www.loticonnection.com

Less, K. H. (2003). *Faculty adoption of computer technology for instruction in the North Carolina community college system.* Unpublished Doctoral Dissertation, East Tennessee State University.

Lipper, D., & Sagehorn, E. (2007). A federal perspective: Timothy J. Magner's take on how technology can improve education. *i.e. Interactive Educator, 3,* 40-41.

Lord, C. (2000). Student achievement in classes with appropriate implementation of technology. Unpublished Research Project.

Lunn, R. J., & Suman, M. (2008). A longitudinal examination of internet diffusion and adopter categories. *Observatorio Journal, 6*(2008), 97-110.

Maguire, L. (2005). Faculty participation in online distance education: Barriers and motivators. *Online Journal of Distance Learning Administration,* 8(1).

McAdoo, S. L. (2005). *An assessment of a teacher laptop program in a southwestern urban school district.* Unpublished Doctoral Dissertation, University of Oklahoma, Norman, Oklahoma.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology, 23*(3), 40-42.

Moersch, C. (1996). Computer efficiency: Measuring the instructional use of technology. *Learning and Leading with Technology, December/January*, 52-56.

Moersch, C. (2001). Levels of technology implementation questionnaire: In-service teacher. Carlsbad: National Business Education Alliance.

Moersch, C. (2002). Measures of success: Six instruments to assess teachers' use of technology. *Learning and Leading with Technology, 30*(3), 10-13, 24-27.

Moore, G. A. (2001). Crossing the chasm and beyond. In R. A. Burgelman, M. O. Maidique & S. C. Wheelwright (Eds.), *Management of Technology and Innovation* (pp. 269). Boston: McGraw-Hill.

National Center for Education Statistics. (2006). *Internet access in U.S. public schools and classrooms: 1994-2005*. Retrieved September 6, 2007. from http://nces.ed.gov/fastfacts/display.asp?id=46

No Child Left Behind Act of 2001, Pub. L .No. 107-110, § 2401, 115 Stat. 1671 (2002).

O'Dwyer, L. M., Russell, M., & Bebel, D. J. (2004). Identifying teacher, school and district characteristics associated with elementary teachers' use of technology: A multilevel perspective [Electronic Version]. *Education Policy Analysis Archives, 12*(48), 1-33. Retrieved September 6, 2007 from http://epaa.asu.edu/epaa/v12n48

O'Riordan, T. (1981). *Environmentalism*. London: Pion Books.

Oppenheimer, T. (2003a, November 30). Computer illogic: Despite great promise, technology is dumbing down the classroom. *San Francisco Chronicle,* pp. D-1.

Oppenheimer, T. (2003b). *The flickering mind: Saving education from the false promise of technology in the classroom*. New York: Random House.

Orr, G. (2003). Review of diffusion of innovations, by Everett Rogers (1995). Unpublished Report.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks: Sage Publications.

Rakes, G., Fields, V., & Cox, K. (2006). The influence of teachers' technology use on instructional practices. *Journal of Research on Technology in Education, 38*(4), 409-424.

Renzulli, J. (2008). Engagement is the answer. *Education Week, 27*(43), 30-31.

Rogers, E. M. (1995). *Diffusion of innovations*. New York: The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Sandholtz, J., Ringstaff, C., & Dwyer, D. (1991). *Student engagement: Views from technology-rich classrooms.* Cupertino: Apple Computer, Inc., Advanced Technology Group, Apple Classrooms of Tomorrow.

Schechter, E. L. (2000). *Factors relating to classroom implementation of computer technology in elementary schools.* Unpublished Doctoral Dissertation, St. John's University, Jamaica, New York.

Segrin, C., & Flora, J. (2005). *Family communication*. London: Rutledge.

Shapley, K., Sheehan, D., Sturges, K., Caranikas-Walker, F., Huntsberger, B., & Maloney, C. (2006). *Effect of technology immersion on teaching and learning: Evidence from observations of sixth-grade classrooms.* Austin: Texas Center for Educational Research.

Shavelson, R. J. (1996). *Statistical reasoning for the behavioral sciences* (3rd ed.). Boston: Pearson Custom Publishing.

Shewey, K. (1998). *Report to the president on the use of technology to strengthen k-12 education in the United States*. Alexandria: American Geological Institute.

State Department of Education. (2003-2004). Public schools no child left behind annual report card [Electronic Version]. Retrieved August 1, 2008, from http://www.okcps.org/fedprograms/rept_cards.htm

State Department of Education. (2004-2005). Public schools no child left behind annual report card [Electronic Version]. Retrieved August 1, 2008, from http://www.okcps.org/fedprograms/rept_cards.htm

State Department of Education. (2005-2006). Public schools no child left behind annual report card [Electronic Version]. Retrieved August 1, 2008, from http://www.okcps.org/fedprograms/rept_cards.htm

State Department of Education. (2006-2007). Public schools no child left behind annual report card [Electronic Version]. Retrieved August 1, 2008, from http://www.okcps.org/fedprograms/rept_cards.htm

Stoltzfus, J. (2005). *Construct validation of the level of technology implementation (loti) survey, in-service teacher version: A preliminary analysis.* Philadelphia: Mid-Atlantic Regional Technology in Education Consortium.

Surendra, S. S. (2001). *Acceptance of web technology-based education by professors and administrators of a college of applied arts and technology in Ontario.* Unpublished Doctoral Dissertation, University of Toronto.

Surry, D. (1997). *Diffusion theory and instructional technology*. Paper presented at the Annual Conference of the Association for Educational Communications and Technology (AECT), Albuquerque, NM. Retrieved August 14, 2008 from http:www2.gsu.edu/~WWWitr/docs/diffusion

Trotter, A. (2007). Getting up to speed [Electronic Version]. *Technology counts: A digital decade*, *26*, 10-12, 14, 16. Retrieved July 22, 2008 from http://www.edweek.org/ew/articles/2007/03/29/30tcpolicy.h26.html?levelId

U.S. Department of Education Office of Educational Technology. (2004). *Toward a new golden age in American education: How the internet, the law, and today's students are revolutionizing expectations*. Retrieved from http://www.ed.gov/about/offices/list/os/technology/plan/2004/site/edlite-default.html

Vaden, J. (2007). A model assessment tool for classroom technology infrastructure in higher education. Retrieved July 31, 2008, from Texas State University Public Administration Program Applied Research Projects Web site: http://ecommons.txstate.edu/arp/207

Vascellaro, J. (2006). Saying no to school laptops: Programs to give all students computers come under fire over costs, inappropriate use by kids. [Electronic Version]. *The Wall Street Journal*. Retrieved July 26, 2008 from http://www.illinoisloop.org/wsj_laptops.html

Vessell, D. (2007). Engaging faculty: The bell curve of faculty technology adoption [PowerPoint Presentation]. Retrieved August 31, 2008 from http://edcommunity.apple.com/ali/galleryfiles/10657/Challenging%20the%20Bell%20Curve%20--... -

Vinograd Bausell, C. (2008). Tracking U.S. trends: States vary in classroom access to computers and in policies concerning school technology [Electronic Version]. *Technology Counts*, *27*. Retrieved July 23, 2008 from http://www.edweek.org/ew/articles/2008/03/27/30dsr.h27.html

Watson, J. (2001). How to determine a sample size: Tipsheet #60. Retrieved August 20, 2008 from Penn State Cooperative Extension Web site: http://www.extension.psu.edu/evaluation/pdf/TS60.pdf

Waxman, H., Lin, M.-F., & Michko, G. (2003). *A meta-analysis of the effectiveness of teaching and learning with technology on student outcomes*. Naperville: Learning Point Associates.

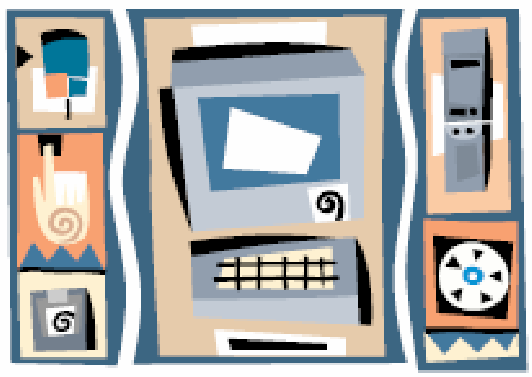
Whitaker, B., & Coste, T. (2002). Developing an effective IT integration and support system. *Journal of Information Technology Education,* 1(1), 54-63.

Wolcott, P., & Goodman, S. (2003). Introducing the global diffusion of the Internet series. *Communications of the Association for Information Systems, 11*(2003), 555-559.

Zakaria, Z. (2001). *Factors related to information technology implementation in the Malaysian ministry of education polytechnic.* Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University.

Appendix A – LoTi Survey Instrument

Levels of Technology Implementation Questionnaire



Version 2.0

Inservice Teacher

 LoTi Questionnaire: Inservice Teacher - 1

LoTi Questionnaire

The following information has been requested as part of an ongoing effort to increase the Level of Technology Implementation in schools nationwide. Individual information will remain anonymous, while the aggregate information will provide various comparisons for your school, school district, regional service agency, and/or state within the LoTi Technology Use Profile. Please fill out as much of the information as possible.

The LoTi Questionnaire (LoTiQ) takes about 15 minutes to complete. The purpose of this questionnaire is to determine your Level of Technology Implementation (LoTi) based on your current position (i.e., pre-service teacher, inservice teacher, building administrator, instructional specialist, media specialist, higher education faculty) as well as your perceptions regarding your Personal Computer Use (PCU), and Current Instructional Practices (CIP) in the classroom. Though the term, technology, may embrace a variety of hardware used in the classroom including calculators, video cameras, and scanners, this questionnaire focuses exclusively on the instructional uses of the computer.

THIS IS NOT A TEST!

Completing the questionnaire will enable your educational institution to make better choices regarding staff development and future technology purchases. The questionnaire statements were developed from typical responses of educators who ranged from non-user to sophisticated users of computers. Questionnaire statements will represent different uses of computers that you currently experience or support, in varying degrees of intensity, and should be recorded appropriately on the scale. Please respond to the statements in terms of your present uses or support of computers in the classroom. For statements that are not applicable to you, please select a 0 response on the scale.

** Indicates that this information is required to correctly process your data.*

Name of State*: ____________________

Name of Intermediate Unit *: ____________________

Name of School District*: ____________________

Name of School*: ____________________

Subject/Specialty: ____________________ **Grade Level:** ____________

Participant ID#* (last 4 digits of SSN): ☐ ☐ ☐ ☐

Do you have computer access at school?*

☐ **Yes**

☐ **No**

Computer access means that students and teachers can use computers within the school building for instructional purposes; including computers in your classroom, computer labs, computers on carts, general access computers in the Library or something similar.

LoTi Questionnaire

Read each response and assign a score based on the following scale:

0	1	2	3	4	5	6	7
N/A	*Not true of me now*		*Somewhat true of me now*			*Very true of me now*	

1 Score __________
I assign daily or weekly computer-related tasks that involve students analyzing information, making predictions, and/or drawing inferences via the internet, computer databases, spreadsheet programs, and/or concept mapping applications (e.g., Inspiration).

2 Score __________
I find computers to be a very effective and powerful tool to present information to students using presentation software such as PowerPoint or HyperStudio. This approach helps my students better understand the content that I teach.

3 Score __________
Designing instructional units that integrate higher-order thinking skills with relevant student-based performance tasks using the available classroom computers is a challenge for me, yet, I still manage to make it happen.

4 Score __________
Students in my classroom design either web-based or multimedia presentations to showcase their research (e.g., information gathering) on topics that I assign in class.

5 Score __________
I have experienced past success with designing and implementing web-based projects with my students that emphasize complex thinking skill strategies such as problem-solving, scientific inquiry, or decision-making.

6 Score __________
My students are involved in establishing individual goals within my classroom curriculum.

7 Score __________
Using cutting-edge technology and computers, I have stretched the limit of instructional computing in my classroom and at my school.

8 Score __________
I have experienced past success with project-based learning in my classroom that emphasizes higher-order thinking skills using the available computers.

9 Score __________
I use computers primarily to support my classroom management tasks such as taking attendance, posting assignments to a web page, using a grade book program, and/or communicating with parents via email.

10 Score __________
In my classroom, students use peripherals (e.g., digital video cameras, scanners, probes), web-based tools (e.g., online surveys, electronic portfolios, web portals), and resources beyond the school building (e.g., partnerships with businesses, interest groups, other schools) to solve authentic problems of interest and importance to them.

11 Score __________
In my classroom, I find the computers (either Windows or Macintosh) to be very effective with improving my students' basic math and literacy skills.

12 Score __________
Technical problems with our network and/or the computer hardware has really prevented me from using our classroom computers.

13 Score __________
I am proficient with basic software applications such as word processing tools, internet browsers, spreadsheet programs, and multimedia applications.

14 Score __________
My students discover innovative ways to use the endless array of classroom computer(s) to make a difference in their lives and in their community.

15 Score __________
I can troubleshoot hardware problems with computers (e.g., printers, peripherals) and/or various software problems (e.g., translations, compression/decompression, cross-platform issues, system management).

16 Score __________
Locating good software programs, web sites, and/or CD's to supplement my curriculum and reinforce basic skills is a major challenge of mine.

17 Score __________
Getting more comfortable with using computers in my classroom is my goal for this school year.

18 Score __________
I am qualified to train others in the use of a variety of software applications (e.g., Excel, Inspiration, PowerPoint), the internet (e.g., web browsers, web page construction and design), and peripherals (e.g., scanners, digital video cameras, probes).

LoTi Questionnaire

Read each response and assign a score based on the following scale:

0	1	2	3	4	5	6	7
N/A	*Not true of me now*		*Somewhat true of me now*			*Very true of me now*	

19 Score __________
The older computers in my classroom really do not fit into my curriculum plans. Until I get a newer computer or software that works with the older computers, I see little use for these older machines.

20 Score __________
In addition to traditional assessments, I consistently provide alternative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways.

21 Score __________
My students use the internet for (1) collaboration with others, (2) publishing, (3) communication, and (4) research to solve issues and problems of importance to them and to their community regardless of their grade level.

22 Score __________
Students in my classroom participate in online collaborative projects (not including email exchanges) with other schools to solve relevant problems of importance to them.

23 Score __________
Given my current work load, it is much easier and more practical for me to send my students to our school computer lab for instruction without me.

24 Score __________
I would prefer to use a curriculum management system that generates specific lesson plans appropriate to my grade level and aligns with district and state standards.

25 Score __________
Using the classroom computers is not a priority for me this school year.

26 Score __________
I seldom have to call someone (e.g., computer technician, system's manager) to figure out a problem with my computer; I have the confidence and expertise to "fix" it myself.

27 Score __________
I prefer using previously-developed, integrated curriculum units that emphasize complex thinking skills, computer use, and student relevancy to the real world.

28 Score __________
My students' authentic problem-solving is supported by continuous access to a vast array of state-of-the-art computer-based tools and technology.

29 Score __________
I seek professional development, software applications, and peripherals that take full advantage of the endless array of computers and technology available to my students.

30 Score __________
I prefer to use existing curriculum units with the classroom computers that emphasize students solving "real" problems or issues of importance to them rather than building my own units from scratch.

31 Score __________
I have an immediate need and interest in contacting other teachers, "qualified" consultants, and/or related professionals who could assist me in my ongoing effort to design student-based performance tasks using computers that involve students making a difference in their school/community.

32 Score __________
Having students apply what they have learned in my classroom to improve their quality of life (e.g., at home, at school, in the community) is a cornerstone to my approach to instruction and assessment.

33 Score __________
I alter my instructional use of the classroom computer(s) based upon (1) the newest software and web-based innovations and (2) the most current research on teaching and learning.

34 Score __________
It is quite easy for me to design student-centered, integrated curriculum units that use the classroom computer(s) in a seamless fashion on my own.

35 Score __________
I use my students' interests, experiences, and desire to solve authentic and relevant problems when planning a variety of computer-related activities in my classroom.

LoTi Questionnaire

Read each response and assign a score based on the following scale:

0	1	2	3	4	5	6	7
N/A	*Not true of me now*		*Somewhat true of me now*			*Very true of me now*	

36 Score __________
Students taking meaningful action at school or in the community relating to the content learned in class is a vital part of my approach to using the classroom computer(s).

37 Score __________
I have an immediate need for more professional development that places greater emphasis on using the classroom computer(s) with relevant and challenging learning experiences rather than how to use specific software applications to support my current lesson plans.

38 Score __________
An important goal of mine is for students to learn how to create their own web page or multimedia presentation that shows what they have been learning in class.

39 Score __________
The types of professional development offered through our school, district, and/or professional organizations does not satisfy my need for more engaging and relevant experiences for my students that take full advantage of both my "technology" expertise and personal interest in developing learner-based curriculum units.

40 Score __________
My students often use the internet for research purposes that require them to take a position, role play an issue, make decisions, and/or seek out a solution.

41 Score __________
My instructional delivery approach enables students to always see and appreciate the relevancy of what I am teaching to their daily lives.

42 Score __________
The curriculum demands at our school such as implementing standards and increasing student test scores has really diverted my attention away from using computers in my classroom.

43 Score __________
I have the background and confidence to show others how to merge technology with relevant and challenging learning experiences that emphasize higher-order thinking skills and student relevancy to the real world.

44 Score __________
Though I currently use integrated, thematic units, it is still difficult for me to design these units to take advantage of the limited (one or two) computers in the classroom.

45 Score __________
My immediate professional development priority is to learn more ways to use limited (one or two) computers to address student outcomes.

46 Score __________
It is easy for me to evaluate software applications, peripherals, and network configurations to determine whether their use in the classroom will support and expand student's critical thinking and authentic problem solving skills.

47 Score __________
My students have immediate access to all forms of cutting-edge technology and computers at any time during the instructional day to pursue their authentic problem-solving surrounding an issue or problem of importance to them.

48 Score __________
Our school really does not provide adequate training for me to take full advantage of the computers in my classroom.

49 Score __________
I have taken and passed multiple online or classroom examinations to become certified with a variety of tool-based applications and network systems.

50 Score __________
Students' questions dictate both the context and content of my instruction.

Appendix B – Additional Demographic Survey Questions

1. What is the name of the school where you are currently employed?

   ____

2. What grade levels do you teach? __Elementary __Middle School __High School

3. Gender ____M ____ F

4. Age ______Years

5. Highest Level of Education ____Bachelors ____Masters ___Doctorate

6. Years of teaching experience: _____ years

7. I have access to a wireless mobile laptop cart in my building.

   1 2 3 4 5

   Not true now somewhat true now very true now

8. I use the wireless mobile laptop cart for classroom instruction.

   1 2 3 4 5

   Never Once Monthly Once Weekly 2-3 times Weekly Daily

9. What barriers do you need to overcome in order to use the wireless mobile laptop cart in your teaching practices?

10. How many hours of ***technology*** professional development training have you had in the last year?

5 or less hours 6-10 hours 11-15 hours 16-20 hours 21 or more hours

Appendix C – Permission to Use LoTiQ Survey Instrument

Greetings!

Welcome to LoTi Lounge! A LoTi Lounge account has been established for the Fletcher-Knight Dissertation Study. Provided below is all the information that your participants will need to register in the LoTi Lounge and get started with the LoTi Questionnaire.

New participants will need the Fletcher-Knight Dissertation Study Group ID and Password to complete a ONE TIME registration sequence that identifies them with the Fletcher-Knight Dissertation Study and as an individual. It may be a good idea to inform participants ahead of time that a User ID, Password, and valid Email address will be required to have full access to LoTi Lounge. Since the LoTi Lounge is a secure system, participants should write down their user information someplace safe to avoid future data retrieval issues. Participants should follow the instructions below to access the LoTi Lounge, take the questionnaire, and optionally print their individual results.

LoTi Lounge Instructions for New Users
----

1. Access the LoTi Lounge at: http://www.lotilounge.com/

2.
Click on the link that says 'Sign Me Up!' (In the 'I'm a New User' section of the LoTi Lounge login block) to complete a ONE TIME registration sequence that will identify you as part of the Fletcher-Knight Dissertation study.

3.
Follow the registration instructions on the screen. You will first be prompted to enter your Group ID and Password.
Group ID: okcps2008
Password: okcps2008

4. Next, you will be prompted to enter your User Information including a User ID and Password of your choosing (NOT the Group ID and Password given above). This User ID and password should be something you will remember as it is what you will use to login to LoTi Lounge in the future.* It is strongly recommended that you WRITE DOWN your selected User ID and User Password information as many school districts take the questionnaire more than once and it is necessary to re-access the LoTi Lounge system.

5.
Next, you will be prompted to enter your Email address. Entering a valid email address is necessary to have full access to LoTi Lounge.

6. Finally, you will be prompted to select your organization from a structural list that has already been entered into the computer based on the Group ID you were given. Choose your organization and click 'Continue' to complete the registration process.

* Note: If you wish to go through the process of taking the questionnaire without receiving a score or so that you can instruct others, simply use the User ID [test_yourname], the password [test], and the email address [yourname@test.com]. Please substitute your name for 'your name' in the previous sentence when creating a test User ID so that the User ID and Password are recognized as unique by the LoTi Lounge system. These records are deleted from the questionnaire database each night.

Please contact me if you have any further questions!

Fred Saunders

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National Business Education Alliance
PO Box 2084
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(V) 760-522-8567
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Appendix D – Institutional Review Board Approval Letter

Oklahoma State University Institutional Review Board

Date:	Tuesday, April 22, 2008
IRB Application No	ED0870
Proposal Title:	The Effect of Wireless Mobile Cart Access on the Level of In-Service Teachers' Technology Implementation in a Southwestern Urban School District
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 4/21/2009

Principal Investigator(s):

Carol Fletcher-Knight
5103 Burr Oaks Rd.
Okla. City, OK 73105

Susan Stansberry
207 Willard
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

[X] The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

Appendix E – Invitation to Teachers to Participate

MEMO

From: Carol Fletcher-Knight, M.Ed.
P.O. Box 20481
Oklahoma City, OK 73156

Dear Colleague,

Have you ever tried to get a bottle of water or a soft drink from a coke machine with a crumpled or even slightly crumpled dollar bill? Many times the machine rejects the bill and we walk away thirsty. Yet, we continue to use coke machines. In fact, most of us have adjusted our practice to keep crisp bills on hand.

In 2001, the citizens of our city passed a historic bond and tax initiative which made $692 million dollars available for school improvement. Fifty-two million dollars were earmarked for technology. As a result, each teacher in our district received a laptop, and Presentation Stations were made available for every two classrooms in each building. The laptop and Presentation Station projects were completed in 2005. In December 2006, two Wireless Mobile Laptop Carts were made available for each building throughout our district.

This letter is to request your participation in a District and Oklahoma State University IRB approved study to investigate the level of use of the Wireless Mobile Laptop Carts in classroom instruction. The survey results are an important way to document the effectiveness of this particular technology purchase, and can be used to help guide the decisions concerning future technology purchases, and technology professional development. In addition, the study results will be used as part of the researcher's dissertation project for the Educational Leadership Department at Oklahoma State University.

In a few days you will receive an email with a consent form and information on how to access the survey which may be completed online. The survey will take approximately 15 to 20 minutes to complete. There are no identified risks of participation. Participation is voluntary, and you will not be identified personally. No individual information is requested or recorded. All findings will be summarized and reported in group form.

The enclosed crisp bill is a token to thank you for your participation. Please enjoy your bottle of water or soft drink. This dollar bill should work!

VITA

Carol Elaine Fletcher-Knight

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECT OF WIRELESS MOBILE CART ACCESS ON THE LEVEL OF IN-SERVICE TEACHERS' TECHNOLOGY IMPLEMENTATION IN A SOUTHWESTERN URBAN SCHOOL DISTRICT

Major Field: Occupational and Adult Education

Biographical:

Education:

Completed the requirements for the **Doctor of Education in Occupational and Adult Education** at Oklahoma State University, Stillwater, Oklahoma in December, 2008.

2001-2004 Oklahoma Baptist University Shawnee, OK

- **B.A., Christian Studies** - Graduated cum laude.

2000–2002 University of Central Oklahoma Edmond, OK

- **M.Ed., Adult Education**. - Graduated with honors.

1992–1998 University of Central Oklahoma Edmond, OK

- **B.S., Human Environmental Science -** Graduated cum laude.

Name: Carol E. Fletcher-Knight Date of Degree: December 2008

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE EFFECT OF WIRELESS MOBILE CART ACCESS ON THE LEVEL OF IN-SERVICE TEACHERS' TECHNOLOGY IMPLEMENTATION IN A SOUTHWESTERN URBAN SCHOOL DISTRICT

Pages in Study: 138 Candidate for the Degree of Doctor of Education

Major Field: Occupational and Adult Education

Scope and Method of Study:

The site of this study was a K-12 Urban School District located in a Southwestern city in the United States. This quantitative study employed cross-sectional survey design method to investigate in-service teachers' level of technology implementation (LoTi) in classroom instruction following a multimillion dollar Wireless Mobile Laptop Cart deployment. Moersch (1995) developed the LoTi framework and the LoTiQ Survey. The LoTi framework is ground in Rogers (1995) Diffusion of Innovations Theory. Eighty-three in-service teachers participated by completing the LoTiQ survey online.

Findings and Conclusions:

Although 90 percent of teachers reported having access to the Wireless Mobile Cart, 60 percent indicated that they never used them. Analysis of teacher's verbatim comments concerning barriers to Wireless Mobile Cart use revealed that 71 percent of the barriers identified were Systemic/Organizational in nature, and proved to be more important for explaining non-use than access or lack of technology proficiency.

Key factors such as Wireless Mobile Cart Access (WMCA), Personal Computer Use (PCU-the indicator of teacher technology proficiency/efficacy), and Current Instructional Practice (CIP) that influence the level of technology implementation in classroom instruction were analyzed to determine if there was a relationship between these factors and teachers' Current Level of Technology Implementation (C-LoTi). CIP and PCU had a moderate and statistically significant relationship with the LoTi level and accounted for 37 percent of the variance in the C-LoTi. WMCA had a significant but weak relationship to C-LoTi. Although the majority of teachers were clustered at the higher intensity levels of PCU and CIP, 55 percent of teachers were clustered in the lower portion of the LoTi framework. Teachers had the requisite technology proficiency and instructional practices to perform at higher LoTi Levels. However, systemic barriers should be addressed to increase teachers' Wireless Mobile Cart use.

ADVISER'S APPROVAL: Dr. Susan L. Stansberry