THE LONGITUDINAL IMPACT OF TECHNOLOGY IMMERSION THROUGH A ONE-TO-ONE MOBILE TECHNOLOGY PROGRAM ON READING AND MATH PERFORMANCE IN A RURAL TITLE I PUBLIC SCHOOL DISTRICT

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Dissertation Prepared for the Degree of

DOCTOR OF EDUCATION

UNIVERSITY OF NORTH TEXAS

August 2015

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Ice, Laura R. *The Longitudinal Impact of Technology Immersion Through a One-to-One Mobile Technology Program on Reading and Math Performance in a Rural Title I Public School District.* Doctor of Education (Educational Leadership), August 2015, 106 pp., 14 tables, 4 figures, references, 101 titles.

In conjunction with the Texas Technology Immersion Pilot program (TIP), the State of Texas implemented a four-year annual evaluation called the Evaluation of the Texas Technology Immersion Pilot (eTxTiP). It focused on the technology immersion experience through one-to-one mobile technology of sixth grade students in 22 selected middle schools. Initial findings suggested academic growth, especially in math, increased rigor of student work, greater teacher collaboration, a more positive school environment, and transformation of instructional practices.

This study focused on one of the original schools selected to participate in the TIP program, exploring the impact over time of one-to-one mobile technology on one group of students over an 8-year period beginning with their third grade year. The selected school’s demographic makeup reflected a large number of schools within the state, including its size, rural location and economically disadvantaged student population. Based on an interrupted time series design, state assessment data was analyzed using a piecewise growth model. The study revealed no statistically significant academic growth in reading and math performance among the participants.
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By

Laura R. Ice
ACKNOWLEDGEMENTS

I would like to express my appreciation to my major professor, Dr. Bill Camp, and the members of my doctoral committee, Dr. James Laney, Dr. Miriam Ezzani, and Dr. Linda Stromberg, for their support during my doctoral studies. I would also like to thank Dr. Jimmy Byrd for his expertise and guidance throughout my research and dissertation project. The completion of this phase of my studies would not have been possible without him. This experience provided me with the opportunity to work with an outstanding group of educators. I will forever be thankful for the friendship and encouragement of Dr. Lance Hamlin, Dr. Robert Bostic, and Dr. Beth Riley, and of Dr. Jefferson George, who was instrumental in the final stage of the dissertation process. Finally, my deepest gratitude goes to Dr. Jane Owen, Dr. Shelley Sweatt, and Dr. Tam Jones for laying the foundation for my graduate studies. Their belief in me and in my abilities both inspired me to take this educational journey and motivated me along the way. The road traveled has taught me about much more than content and process; relationships have been forged and experiences shared. The challenges and perseverance required have expanded my knowledge, strengthened my fortitude, and deepened my character. For these gifts and these individuals, I will always be grateful.
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CHAPTER 1
INTRODUCTION

As school districts across the country struggle with the challenges and repercussions produced by assessment and accountability-driven mandates, schools are searching for ways to increase student academic performance. Initial studies have linked the immersion of technology to increased student achievement, leading to an influx of district- and campus-wide technology initiatives. The ubiquitous format of one-to-one mobile computing has been established as the foundation of school technology programs and is positioned to be a tool for both school reform and the transformation of learning. But as financial reins have tightened, schools’ need for sound evidence of mobile computing as an effective and efficient technological learning tool has heightened. The added financial constraint has influenced school districts to look at alternative forms of one-to-one delivery, making this study especially relevant in today’s current exploration of online learning platforms and bring your own device (BYOD) formats. Regardless of whether the device is district or student owned, the premise rings clear: one-to-one mobile technology continues to be a viable learning tool in the educational environment.

The application of digital literacy skills as a tool toward increased knowledge (Prensky, 2012) is especially significant in the push toward college and career readiness and 21st Century Skills. It is within this framework that critical thinking, problem solving, communication, collaboration, creativity, and innovation are infused into the core content. It is also through this lens that schools strive to meet the needs of students living in a technology-driven world where information is at their fingertips, on-demand collaboration is the norm, and the capabilities of personal technology tools continue to advance (Partnership for 21st Century Skills, 2014). Effective technology integration and access to devices shift the control of learning to the student,

toward increased engagement and improved learning outcomes by empowering the student to be an active participant in the learning process through relevant and meaningful learning opportunities (Dixon & Tierney, 2012; Johnson, 2012; Tech & Learning, 2012; Ullman, 2011). Digital technology transforms the learning process by elevating the computing device to a learning device. Essential to its role in constructing new knowledge is the capability to research, organize, communicate, integrate, evaluate, and analyze information. Information, communication, and technology (ICT) skills available through information literacy, media literacy, and ICT literacy afford opportunities for a broad range of knowledge needed to make contributions to the information age and compete successfully in the global workforce (Holubz, 2012; Partnership for 21st Century Skills, 2014).

Until now, the rapid growth in the adoption of mobile devices within the school environment has not allowed a longitudinal perspective to come into view (Burke, Brooks-Young, & Waker, 2012). Extensive time is needed to understand the effects of ubiquitous computing on student learning and the school environment; however, most research has been bound by the confines of state- and district-wide one-to-one computing project evaluations (Lei & Zhao, 2008; Penuel, 2006). The large-scale funding required for implementation of one-to-one mobile computing initiatives has raised questions about its effectiveness and efficiency with regard to the innovation’s return on investment (Lei & Zhao, 2008).

Background of the Study

The Texas Technology Immersion Pilot (TIP) program, described as the “mother of all laptop programs” (Villano, 2006) was implemented through a grant process in the fall of the 2004-2005 school year and focused on 22 high-need middle schools with a large number of
schools located in rural areas and small districts in Texas, many of those in isolated sites. The remaining high-need middle schools were located in large cities or suburban locations in or around cities. Approximately 70% of the students in the grant’s participating schools were designated economically disadvantaged based on Title II, Part D funds eligibility requirements, which include family incomes below the poverty line, schools in need of improvement, and schools with a substantial technology deficiency. Students also came from a range of ethnic backgrounds, with 56% Hispanic and 9% African American. The information gained through the pilot was to be used at the state level to assess the effectiveness of technology immersion on middle school students’ achievement in the four core areas: mathematics, language arts, science, and social studies (Shapley et al., 2006).

The pilot included six major pieces: a wireless mobile computing device for every middle school student and teacher, allowing for 24/7 access to technology; productivity, presentation, and communication software; online instructional resources targeting the four core content areas of English language arts, mathematics, science, and social studies; online assessment tools allowing for both diagnostic and progress monitoring; professional development encouraging the integration of technology into curriculum and instruction; and technical support both initially and ongoing.

TIP was one of the few one-to-one mobile computing initiatives that included an evaluation tool disseminated annually over a four-year period. The tool, called the Evaluation of the Texas Technology Immersion Pilot (eTxTiP), examined technology immersion’s impact on the academic achievement of middle school students in core subject areas. The design matched 22 technology immersion schools with 22 control schools of like characteristics, including size,
regional location, demographics, and student achievement. The annual evaluative reports provided authentic feedback delivered in a timely manner (Shapley et al., 2006).

Purpose of the Study

The purpose of this study is to examine the long-term academic impact of a one-to-one mobile computing technology initiative on a small economically disadvantaged rural school district’s students in reading and mathematics as a result of the district’s initial participation in TIP and its continuation of the one-to-one mobile technology initiative. The selected school’s rural location and high percentage of economically disadvantaged students mirror the issues faced by many schools across the state and nation. The school district’s ability to implement one-to-one mobile computing through TIP’s grant process, continue the technology initiative after the completion of the study, and expand the initiative to additional grade levels is imperative to the district leadership’s commitment to digital learning as a tool for school reform. In addition, TIP serves as a landmark educational study in the area of one-to-one mobile computing, and the selected school’s status as a participating “immersed” school makes it an excellent candidate for further review of technology immersion’s long-term impact on student achievement. Therefore, to better understand the academic impact of digital learning, the study investigates the district’s student achievement on the annual state reading and mathematics assessments both before and after implementation of mobile computing devices. Central to this topic is the work of identifying the purpose of TIP; revisiting TIP’s key components, including mobile computing devices, software, online curricular resources, assessment, professional development, and technical support; and examining the eTxEiTIP four-year evaluation.
Theoretical Framework

TIP was built upon the theory of technology immersion. The Texas Education Agency (TEA) selected this model based on existing educational technology research and information gained through pilot studies and statewide technology initiatives. The model is grounded in the premise that effective technology includes robust technology access and a solid infrastructure to promote increased use; state-aligned curricular and assessment resources designed to provide relevant, rigorous, authentic learning and increased student engagement; ongoing technical and instructional support to foster successful use of the devices; and timely professional development to instill educators with the skills needed for effective technology integration (Shapley et al., 2006).

ETxTiP, the evaluation piece of TIP, is based on the theoretical framework of technology immersion. The framework uses a research design to identify the effects and determine the differences of the technology intervention on 22 technology-immersed schools compared to 22 non-technology immersed schools. The immersed schools, also known as the experimental or treatment group, were studied alongside the non-immersed, or control group, for a period of four years through three cohorts initiated at the sixth grade year. Cohort 1 followed the grant’s 2004-2005 sixth grade classes for four years and included a total of 5,564 students at both technology-immersed and non-immersed schools. Cohort 2, the 2005-2006 sixth grade classes, was monitored for three years, while Cohort 3, the 2006-2007 sixth grade classes, was monitored for two years (Shapley et al., 2006).

In conducting the eTxTiP study, researchers used both qualitative and quantitative measures to examine four areas: the relationships that exist among contextual conditions; technology immersion within each participating school; intervening factors such as school,
teacher, and student; and student academic achievement. The final area, a critical component of the evaluation piece, stems from technology immersion theory: the idea that increasing the access of teachers to technology promotes greater technology proficiency, professional productivity, collaboration, and intellectually challenging lessons. Accordingly, parallel school and classroom conditions lead students to greater technology proficiency, peer collaboration, personal self-direction, and stronger school and learning engagement. The resulting outcomes, when implemented with fidelity to full immersion, result in increased academic performance as gauged through the annual state assessment. ETxTiP’s experimental research design utilized the difference between the treatment and control group to estimate the effects of the intervention. The causal relationships provided through the evaluation were formatted through a linear sequence; thus the fidelity of the evaluation hinged on quality implementation (Shapley et al., 2006).

Initial findings showed approximately 91% of the technology-immersed schools, 20 of 22, met only partial immersion the first year of implementation. The remaining 9% met substantial immersion, and no schools reached full immersion. The ETxTiP First-Year Results report noted an emphasis on professional development and the presence of strong district and campus leadership in the two middle schools reaching substantial immersion (Shapley et al., 2006). Over the evaluation’s four-year time span, schools reaching substantial immersion grew by only four, totaling 25%. Despite the minimal degree of implementation, positive effects were reported at the school, teacher, and student levels (Shapley et al., 2006; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2009). The report’s review of the three cohorts’ progress indicated varied levels of increased performance on the reading and math sections of the annual
state assessment, including positive sustaining effects in both content areas for Cohort 1 after three years of participation in the one-to-one initiative (Shapley et al., 2009).

This study continues to use the technology immersion framework which guided TIP by focusing on one of TIP’s Cohort 1’s participating schools at first-year implementation and following it through the school district’s sustainment of one-to-one mobile computing. For the purpose of this study, the state reading and mathematics assessment data over an eight-year period beginning with the 2001-2002 third grade students at a selected public school district were used. Each year the district serves approximately 800 students pre-kindergarten through Grade 12 on elementary, middle school, and high school campuses (Texas Education Agency, 2005a). In 2004, the school district’s middle school was selected through a grant application process by the Texas Education Agency (TEA) as one of 22 sites to participate as a technology immersion school. The grant process required applying districts to meet the eligibility requirements of Title II, Part D funds, which established qualification based on family incomes below poverty level, schools in need of improvement, or schools with substantial technology need (Shapley et al., 2006). These federal funds were made possible through the Enhancing Education through Technology Act of 2001, which targeted student improvement though effective technology integration (U.S. Department of Education, 2004). The initial implementation of TIP utilized these funds to provide all faculty and students on the Grade 6-8 middle school campus with Apple laptops. Through the support of the district’s school board, the one-to-one program was extended the following year with local funds to include the high school campus. At present, all grade levels within the district have access to laptops during the school day with students enrolled at the secondary level having access 24/7 during the school year (Vaughn, 2010).
The goal of this study was to provide a longitudinal analysis to identify the effect of one-to-one mobile technology on student academic performance and growth; examine the academic impact of one-to-one mobile technology on various student populations; and investigate the academic impact of digital learning through technology interventions and initiatives at implementation and sustainment levels.

Statement of the Problem

The problem identified for this study examined student growth and the long-term academic impact of a one-to-one mobile computing technology initiative on an economically disadvantaged rural school district as a result of the district’s initial participation in TIP and its continuation of the one-to-one mobile computing technology initiative as measured on the annual state assessment before, during, and after implementation of TIP.

In order to investigate the educational impact of one-to-one mobile computing over time, student reading and mathematics assessment data over an eight-year period were collected for a selected grade level from a selected school district. A piecewise growth model was used to analyze the group’s individual student data at three points in time: pre-intervention, implementation of the intervention, and post-intervention. Due to the decline in sample size over time, the specific student populations which included at-risk, economically disadvantaged, ethnicity, limited English proficient (LEP), and special education were excluded from the study.

Research Questions

The following research questions were developed to guide this study:

1. Does the implementation of technology immersion through one-to-one mobile computing
devices impact the reading performance of students in a selected rural Title I public school district over time?

2. Does the implementation of technology immersion through one-to-one mobile computing devices impact the math performance of students in a selected rural Title I public school district over time?

Limitations

The limitations of the study are as follows:

- Continuity of membership of the selected student group over the eight-year period.
- The fidelity of implementation of TIP throughout the grant period at each grade level and in each classroom.
- The fidelity of technology immersion after the implementation period during the student group’s high school years.
- The impact of “disruptive innovation” in relation to teacher acceptance/resistance to one-to-one mobile computing devices as a learning tool.
- The change of Texas state assessments during the 2002-2003 school year from the Texas Assessment of Academic Skills (TAAS) to the Texas Assessment of Knowledge and Skills (TAKS).

Definition of Terms

- *At-risk:* A student under the age of 21 who is at risk of dropping out of school and meets one of a number of criteria including failure to maintain a 70 or higher in two or more core-content subject areas or failure to perform satisfactorily on the annual state
assessment.

- **Bring your own device (BYOD):** A policy or procedure allowing students to bring personal mobile computing devices to school to use for educational purposes. Devices may include laptops, netbooks, tablets, and smart phones.

- **Economically disadvantaged:** A student who is eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Program.

- **Ethnicity:** Student classification includes American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic origin, Hispanic, or White.

- **Evaluation of Texas Technology Immersion Pilot (eTxTiP):** A four-year research study funded through a grant to evaluate the implementation and effectiveness of the Technology Immersion Model administered through TIP on student achievement.

- **Limited English proficient (LEP):** A classification signifying a student using a language other than English as the primary home language. The determination that English language proficiency is limited is based on the decision of the Language Proficiency Assessment Committee (LPAC) or a test of English proficiency. Bilingual programs or English as a Second Language (ESL) instruction is often used to support student learning.

- **Mobile computing:** Computing that allows devices to be transported with continued access to Internet, software, and any needed files.

- **No Child Left Behind (NCLB):** An act signed into law in 2001 by President George W. Bush as a reauthorization of the Elementary and Secondary Education Act (ESEA). The Act supports standards-based education reform founded on set educational standards and established measurable goals with a focus on closing the achievement gaps toward increased academic success of all students and meeting federal accountability
• **One-to-one computing:** An education technology initiative in which every student has access to a personal computing device with Internet access allowing anytime-anywhere learning. Devices may include laptops, netbooks, tablets, and smart phones.

• **Special education:** A program that serves students with disabilities through instructional and related educational support programs and services.

• **Texas Assessment of Academic Skills (TAAS):** A state standardized test administered to Texas students grade 3-11 to assess students’ achievement of the reading, writing, and mathematics skills required to meet the state’s grade level education standards. TAAS was administered to students from 1991 to 2002.

• **Texas Assessment of Knowledge and Skills (TAKS):** A state standardized test administered to Texas students grade 3-11 to assess students’ achievement of the reading, writing, mathematics, science, and social studies skills required to meet the state’s grade level education standards. TAKS was introduced in the 2002-2003 school year and used to fulfill the test accountability measures set forth in No Child Left Behind. TAKS began a phase out process in 2012.

• **Technology immersion:** The process of immersing technology into teaching and learning through implementation of robust access to technology, technical and pedagogical support, educator professional development, and access to state standard-aligned curricular and assessment resources.

• **Technology Immersion Pilot (TIP):** A technology immersion project conducted by the state of Texas at high-need middle schools through a competitive grant process.
• **Title I:** A provision of the original Elementary and Secondary Education Act. Title I provides funding to school districts and schools with high percentages of students from low-income families to improve disadvantaged students’ academic achievement.

• **Title II Part D:** Known as the Enhancing Education Through Technology Act of 2001. Title II Part D provides federal funds to high-need local education agencies to improve student academic achievement at the elementary and secondary levels through effective implementation of technology. Its goal is to also ensure every student is technology literate by eighth grade regardless of demographics, disability, or geographic location.
CHAPTER 2
LITERATURE REVIEW

Introduction

The review of literature begins by exploring the current enrollment of rural and economically disadvantaged student populations in relation to the educational impact of one-to-one mobile computing initiatives and the longitudinal effects of the Texas Technology Immersion Pilot. With over 1,200 school districts and charters located within the state of Texas, and more than half the student population designated economically disadvantaged (Texas Education Agency, 2013), educators are searching for ways to increase student learning and meet both state and federal accountability measures. The continued integration of mobile technology within the learning environment has produced an ongoing transformation of curriculum and instructional delivery. Educators’ increased understanding of how students learn has resulted in huge shifts and cycles in technology integration, impacting both teaching and learning. As a result, instructional strategies have been developed to align with increased access to technology (Donovan, Green, & Hartley, 2010; Shapley et al., 2006; Sims, 2008).

In an attempt to meet No Child Left Behind’s (NCLB) goal of improving student achievement, various methods of organizational change have been attempted (Thornton, Peltier, & Perreault, 2004). One-to-one laptop initiatives have proven a viable means to increase student academic performance by infusing technology into learning environments built on engagement, higher order thinking, and relevance (Barrios et al., 2004; Donovan et al., 2010; Murphy, King, & Brown, 2007). Accompanied by ongoing teacher professional development, one-to-one initiatives have the promise to transform education and produce increased academic achievement
(Barrios et al., 2004; Brown, 2003; Cavanaugh, Dawson, & Ritzhaupt, 2011; Harris & Smith, 2004; Papert, 1980; Spires, Oliver, & Corn, 2011; Stager, 1995).

Rural Schools and the Economically Disadvantaged Student Population

The Texas Technology Immersion Pilot grant process required applicants to meet eligibility requirements for Title II, Part D funds which target high-need schools due to one of three criteria: family income below the poverty level, schools identified for improvement, or schools with significant need of technology. As a result, 22 schools were chosen for participation in TIP based on specific characteristics, including school size, regional location, school demographics, and student academic achievement. While approximately one-third of the participants were from large cities or suburban areas in or around cities, approximately two-thirds of the participants hailed from rural and small school districts across the state, many in geographically isolated locations. Within those 22 sites, approximately 70% of the students were from economically disadvantaged backgrounds, with 56% Hispanic and 9% African American (Shapley et al., 2006).

Texas covers a large geographical area and includes a vast range of school sizes and varied student populations. The diversity of the state and the composition of its public school system are important in understanding the issues related to this study. While not all small schools are rural and not all rural schools are small, the lens through which this area is viewed is multi-dimensional. TEA’s 2011-2012 Pocket Edition showed approximately 300,000 Texas students attended schools with enrollments of 999 students or less. This number accounted for only 5.8% of the student population within the state; however, it accounted for 691 of the state’s 1227 districts, or 56.31% of the school districts (Texas Education Agency, 2013). These
enrollment reports, made possible through the Public Education Information Management System (PEIMS), provide pre-kindergarten to Grade 12 enrollment data through a snapshot picture of student enrollment within the state for campuses, school districts, charter schools, counties, education service center regions, and the state. Within the snapshot, enrollment data includes student demographic information such as race/ethnicity, gender, and economically disadvantaged status as well as student characteristics and program participation. The enrollment trends identified in these reports reflect changes in society and are imperative for monitoring students’ educational progress and planning the state’s future educational needs. Enrollment data, which is required to meet NCLB guidelines and both federal and state accountability requirements, is submitted and categorized by race/ethnicity, gender, economically disadvantaged status, students with disabilities, and students with limited English proficiency. In addition, state report cards disaggregate district and campus information by race, ethnicity, gender, disability status, English proficiency, and economically disadvantaged status. Based on Texas Education Code [TEC] §39.053, student performance is then reported by student population and student group categories. Student achievement is required to be disaggregated by race, ethnicity, and socioeconomic status (Texas Education Agency, 2012). The Rural School and Community Trust’s 2011-2012 biennial report illustrates the rural composition of Texas schools in a much different light, noting that 31.9% of the state’s schools are designated rural schools with a total enrollment of more than 834,000 students, or 18% of the student population. These numbers represent the largest rural school enrollment in the nation and claim the nation’s largest increase over the past nine years. The report uses the National Center for Education Statistics (NCES) 12-item urban-centric locale code to define “rural” and offers three designations: rural fringe, rural distant, and rural remote (Strange, Johnson, Showalter, & Klein,
2012; U.S. Department of Education, 2012). Using this definition, the NCES report indicated the percentage of minority students and mobility rates in Texas to be among the highest in the nation. Independent statistics within the report showed approximately 43.9% of the state’s students were identified as rural minority based on NCES categories of American Indian/Alaskan Native, Asian/Pacific Islander, Black, and Hispanic; 9.4% of rural students within the state qualified for services as English language learners (ELL); 13.9% of households within the state were categorized as rural student mobility due to changes in residences of school-age children within a twelve-month period; and 42.6% of rural students age 5 through 17 within the state fell below the federal poverty level and therefore qualified their school districts for Title I funds. In contrast, educational outcome results were slightly below the national average, with low instructional spending and a weak state funding contribution (Strange et al., 2012).

As the number of small schools has increased within Texas, so have the number of students identified as economically disadvantaged. Under TEA guidelines, students who are eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Program are identified as economically disadvantaged. Reports indicate that from the 2001-2002 to 2011-2012 school years, an increasing number of students met TEA’s criteria, with a 43.7% increase in the identification of economically disadvantaged students in the state of Texas. Reports for the 2011-2012 school year showed a total of 3,013,442 students, or 60.3% of all students, identified as economically disadvantaged. In contrast, this 43.7% increase was more than double the 20.1% increase observed in the state’s school-wide enrollment within the ten-year period (Texas Education Agency, 2005b; Texas Education Agency, 2012).

Title I is a federally-funded program designed to meet the educational needs of the economically disadvantaged student population. The program was originally authorized in 1965.
under Title I of the Elementary and Secondary Education Act and is currently tied to the No Child Left Behind (NCLB) Act. It serves as the largest federal aid program available for elementary and secondary schools with a primary focus on reducing the gap between advantaged and disadvantaged students as well as special needs populations. Schools that qualify for Title I assistance must have an economically disadvantaged student population of 40% or more who are at-risk of failing to meet state standards. Title I provides services through targeted Title-I funded programs or through campuses that receive school-wide Title I assistance in an effort to increase student performance through improved teaching and learning (Texas Education Agency, 2009; Texas Education Agency, 2012)

Rural Schools and Technology Integration

Rural schools and students comprise a significant portion of the nation’s educational profile. With approximately 23% of America’s public school educators and 20% of public school students located within rural school districts, rural schools face challenges unlike non-rural educators and students (Beesley, 2011). A critical component in the educational equation is equity in providing rural students the same quality of educational experience as that which can be achieved at an urban or suburban school. In order for the rural student to be globally prepared, it is imperative that a connection exists to the world (Gordon, 2011). Limited access to advanced level courses, on-site support, and needed course materials hinders students’ ability to receive full opportunity and the fundamental resources required to meet educational aspirations, including post-secondary enrollment (Beesley, 2011). Furthermore, for many rural school districts, a lack of infrastructure and funding, and a shortage of tech-savvy teachers, staff, and potential stakeholders often play a part in creating barriers to effective technology
The emergence of technology in rural America has proven invaluable in removing the educational obstacles created through remote geographical proximity (Gordon, 2011). Online options are one alternative for meeting the challenges produced through remote geographical proximity. Teacher professional development and mentoring programs, virtual field trips, and online course offerings bridge the gap between the rural and non-rural educational environment (Beesley, 2011).

Despite the assumption of many online course and professional development providers that rural schools fail to meet the technology implementation levels of their counterparts, the individualization of rural schools allows for varied levels of technology proficiency. Internet access in rural areas is diverse and highly influenced by local conditions. For many rural school districts, a lack of reliable, robust and economically feasible Internet connectivity exists (Beesley, 2011; Gordon, 2011). In other cases, a number of rural school districts have shown to have highly sophisticated technology conditions (Beesley, 2011). Successful technology implementation requires district leadership to find innovative avenues for Internet access so that students who lack Internet connectivity are not left behind. Partnerships with community libraries and major universities as well as grants focused on emerging technologies have proven beneficial in assisting rural school districts to overcome the barriers that impede student access to technology. Wentworth School District, a K-8 school located west of Plymouth, New Hampshire, relied on the grant process for funding to equip the district with a range of technology devices needed to meet its educational technology initiatives. Despite nearly half of the rural school district’s student population coming from economically disadvantaged homes and approximately one-fifth of the students having an educational disability which adversely affected students’ educational programs, the implementation of emerging technologies proved
academically beneficial. The school district’s administrative principal reported that through the implementation of technology in the classrooms, state test scores showed English language arts proficiency levels to have increased from 51% in 2008 to 78% in 2011, and math proficiency climbed from 39% to 70% (Gordon, 2011).

An additional layer of effective technology implementation rests in rural school districts’ ability to access technology leadership. The pool of candidates available to lead rural districts toward technology implementation is considerably less, and the ability to recruit this level of leadership to remote locations is challenging (Gordon, 2011). The large number of rural school districts across the country and the varied levels of technology leadership within each one results in diverse and wide-ranging capabilities to achieve successful technology implementation. This is in contrast to larger school districts that may be under one technology director for dozens of schools. However, connecting the same number of students in classrooms from a large number of rural schools as opposed to meeting that same number within one urban or suburban school is labor-intensive (Beesley, 2011).

Ground Floor One-to-One Initiatives

The transformation of technology over the last decade has been both dramatic and fast paced especially in the hands of learners. The portability and ubiquitous formats of one-to-one computing devices have propelled anytime-anywhere learning to a commonality. What was once an innovation used by a few has evolved to widespread use. Several landmark one-to-one computing initiatives paved the way toward this trend and provide a historical understanding of the innovation’s initial implementation and impact on teaching and learning (Lei, Conway, & Zhao, 2008). Villano (2006), O’Hanlon (2007), and Givens (2007) examined the Texas’
Technology Immersion Project (TIP). This program, described by Villano as “the mother of all laptop programs” (2006, para. 3), was formed through state legislation and became a public-private partnership between the Texas Education Agency, the individual school district, and consulting, communication, research, evaluation, and vendor partners (Villano, 2006). Givens, who served as the Senior Director of Instructional Materials and Educational Technology for the Texas Education Agency, provided an example of how one-to-one computing efforts through technology-supported systemic reform can “throw open the world to formerly closed-off public schools, and that being isolated no longer means being disconnected” (Givens, 2007). Givens (2007), O’Hanlon (2007), and Villano (2006) each noted that the TIP program was one of the few one-to-one technology initiatives that had an evaluation tool (eTxTiP) built into it, and initial results proved positive. Chesterfield County School District’s program titled Student Technology and Education Proficiency Initiative (STEP) was touted as “much more than a laptop program” (Fox, 2009, para. 4). The initiative utilized NCLB’s Title II-D funds to provide laptops to sixth and seventh graders within the district for use both at home and at school. An agreement was made with the local telephone company to provide low-income families free Internet installation and a reduced monthly service fee. The goal was comprehensive in its attempts to utilize technology as a means to improve teaching practices and academic achievement through increased student engagement. The initiative included an array of digital tools for use within the classroom, tech coaches for technology integration support, and ongoing professional development allowing teachers the resources needed for innovation and integration (Fox, 2009).

Classroom Connections, South Dakota’s one-to-one laptop initiative, called for a laptop to be made available to every high school student within the state. The program design instilled a
deep connection between the education and business world, including partnerships with Citibank, Gateway, Microsoft, and Cisco (Gorder, 2007). Through the combined corporate support, Gateway convertible notebook computers were provided to approximately 5,000 students in the pilot group (Livingston, 2007).

The Maine Learning Technology Initiative (MLTI) was created by the Maine Department of Education (O'Hanlon, 2007). Implemented in 2001 at a cost of approximately $120 million (Weston & Bain, 2010), Maine’s one-to-one initiative holds the title of the largest one-to-one deployment in the nation. Initially it created wireless infrastructures in each of the state’s 239 middle schools and provided laptops to all 34,000 seventh and eighth grade middle school students and their teachers, with plans for expansion to every elementary and high school student within the state (Villano, 2006). In addition to providing ubiquitous computing, the initiative provided technical support and relevant professional development targeted at both the initial implementation and ongoing stages (Silvernail & Gritter, 2007). The initiative was renewed after four years (Quimby, 2007), and within five years the initiative had provided a one-to-one mobile learning environment to approximately 100,000 middle school students and their teachers within the state (Silvernail & Gritter, 2007).

Other groundbreaking one-to-one initiatives included Michigan’s Freedom to Learn (FTL) and Cincinnati Country Day School (O'Hanlon, 2007). FTL was funded through both state and federal funds and coordinated by the Michigan Department of Education and Ferris State University. After an initial pilot program during the 2001-2002 school year, the program was fully implemented in 2003, targeting sixth grade middle school students from approximately 100 underperforming, low-income districts within the state (Villano, 2006; Wilson & Peterson, 2006). Schools were termed “innovative laboratories” as a means to promote student-centered,
rigorous and relevant learning experiences. The one-to-one mobile computing initiative centered on four objectives designed to enhance student learning and achievement, increase access to equal educational opportunities, support technology integration through professional development, and extend outreach to parents and caregivers to increase involvement in students’ education. Stakeholders viewed the inclusivity of the program through hardware and software, ongoing professional development, stakeholder support and ownership, and research-based practice as imperative to the initiative’s success (Wilson & Peterson, 2006).

Cincinnati Country Day School partnered with Toshiba and a solution provider in 1996 to assist in the deployment of their one-to-one program (McHale, 2006; Villano, 2006) Six years later the Grade 5-12 private school began the transition to personal tablets with the 5th grade class. Full implementation of personal tablets for the school’s 575 students and 150 teachers was achieved in 2006. The school received no federal or state financial support, and parents or guardians bore the cost of students’ devices. Financial aid was available to those students’ families who qualified, and the school provided devices to all teachers, both of which made the one-to-one initiative costly to the school. Professional development was covered in-house through teachers sharing their knowledge with colleagues and visiting schools (McHale, 2006). In a similar effort, Catskill Central School District also partnered with the corporate world, teaming with giant IBM in a lease program. The school-business partnership freed the school district from the financial burden of owning devices that would depreciate over time as innovative technology tools and instead allowed for the technology initiative to remain fresh as computing device hardware was upgraded as leases were renewed (Villano, 2006).
Disruptive Technologies

Sharples (2000) noted that previous research has linked increased student gain to teacher effectiveness, listing teachers’ classroom organization, management of student behavior, and enforcement of rules as key ingredients to increased academic achievement. Despite a firm understanding that students learn best when constructing their own knowledge through relevant, meaningful learning experiences driven by inquiry and collaboration, widespread access to new forms of mobile technologies combined with improved communication and computing capabilities threatens the pedagogical control factor ingrained in the educational workplace. For many schools, mobile computing devices disrupt traditional teaching methods and are deemed disruptive to the educational environment. The result is a learning environment that includes banned devices and sharp teacher resistance (Sharples, 2000).

These disruptive tendencies are actually part of much larger forces at work. In 1997, Harvard business professor Clayton Christenson coined the term “disruptive innovation” as a means to explain the experience of the consumer when new innovations transform the existing market by providing a simpler, more convenient, accessible, and affordable method. The disruption, much like a sustaining innovation, is a positive force; however, a disruptive innovation goes beyond making a product or service better in order to sustain current levels. A disruptive innovation increases access to a larger population by redefining what is considered by the masses as good, quality, or acceptable. Over time the new definition transforms the existing area. While Christenson’s lens originally focused on the business world, the principles of the disruptive innovation theory carry over into numerous other fields, including education. Disruptive innovations have the ability to transform the classroom and instructional delivery in the 21st century by moving from standardization to individualization, increasing universal access
and equity, and providing the tools to increase productivity, all essential components to meeting the needs of today’s learners within a growing economically disadvantaged student population. Digital technology aligns itself with the theory’s premise and becomes key to instituting varied instructional delivery, including hybrid online learning formats such as blended learning and flipped classrooms (Christensen, Horn, & Staker, 2013; Clayton Christensen Institute, 2012; Education Week, 2014).

Support through teacher education and ongoing professional development is critical to clearing the obstacles produced through disruptive innovations. The rapid influx of digital innovations, coupled with the demands of school improvement, continues to change the landscape of education, creating a shift in the role of educators and a need to retool educational thinking and policy. Educators assume positions as mentors, coaches, and problem solvers to a more individualized audience; teachers require personalized instruction to meet the many and diverse needs of their students; and students need increased levels of engagement to foster the essential thought and skills critical to successful learning (Education Week, 2014). Warschauer stated the importance of teacher training and support in order to overcome resistance to technologies and the proficiency anxieties that accompany implementation. Providing training and support ensures that innovations are successfully integrated into the learning environment (Education Week, 2014; Hu, 2007).

One-to-One Concerns

In the context of one-to-one mobile computing devices in the educational arena, a fundamental belief exists that a ratio of one computer to one user will result in meeting state and district-led goals of school reform and increased student academic achievement (Weston & Bain,
The visibility of school-wide deployments in conjunction with intensive labor and financial outlays has established a certain level of expectancy; as a result, one-to-one initiatives have experienced intense scrutiny with regard to effectiveness and efficiency. Many schools discontinued their one-to-one computing initiatives within the first few years of implementation (Lei & Zhao, 2008). Norris and Soloway (2008) cited correlating documentation provided by the New York Times in May 2007 and noted that the expense required to fully fund one-to-one initiatives had far exceeded what districts could afford.

Central to technology immersion and school-wide one-to-one deployment is the hope of increased student achievement. However, several studies report just the opposite. The implementation of one-to-one computing waivered among Maine Learning Technology Initiative (MLTI) schools, and student performance showed minimal change in academic performance on the eighth grade Maine Education Assessments (MEA) (Weston & Bain, 2010). Not until the fourth year of the Technology Immersion Pilot’s (TIP) implementation did student scores on the Texas Assessment of Knowledge and Skills (TAKS) begin to show significant and sustaining improvement (Shapley et al., 2009; Weston & Bain, 2010). Both MLTI and TIP school evaluations reported inconsistencies in implementation and levels of full immersion among schools (Shapley et al., 2006; Shapley et al., 2007; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2008; Shapley et al., 2009; Weston & Bain, 2010).

One-to-one computing devices are also charged with the ability to bridge and eliminate academic gaps in student learning derived through economical or racial/ethnic diversity. Although access to the innovation levels the playing field at school, it does not erase the academic inequities between students. One-to-one technology access provides those with at-home access the same educational benefits, building on those students’ prior experiences and
thereby continuing to foster an educational gap among students (Warschauer, 2005). The lack of evidence of increased student academic achievement has prompted a multitude of school districts to abandon one-to-one initiatives. Programs once viewed as innovations that would lead to increased academic performance and as tools to arm students with 21st century technology skills were subsequently phased out of existence. For these districts, the technical and logistical issues of providing digital learning environments, the ongoing professional development required to increase technology proficiency and combat teacher resistance, and the mounting cost of maintenance of hardware and mobile devices convinced school officials that the investment had not produced the desired outcome and should be discontinued (Hu, 2007).

Warschauer (2005), a technology proponent, noted a number of issues that could result in minimal to no score gain. He cited a major disconnect between digital learning and the paper-and-pencil format of assessments as a contributing factor. He also noted the relatively young age of one-to-one mobile computing, suggesting that the newness of one-to-one programs has not allowed for the time needed for the initiative to fully mature in terms of improved academic performance (Hu, 2007; Warschauer, 2005). Studies show that reform efforts generally take five to eight years of full implementation in order to produce significant results; similarly, the fidelity of full implementation of large-scale initiatives may alter the results of student performance across districts and campuses. Furthermore, a number of one-to-one initiatives rely on local control, resulting in varied timing and flexibility for the introduction of the innovation, as well as constraints on financial and human resources that hinder the ability of districts to reach full technology immersion (Silvernail & Gritter, 2007). Similarly, a large number of school districts lack those same necessary resources required to conduct a sound evaluation of one-to-one
programs at the local level, thwarting efforts to provide an accurate assessment of the district’s technology initiative (Hu, 2007).

The MLTI utilized funding, training, and support as the foundation for its initiative’s success. However, as Crystal (2002) was quick to point out, that funding failed to cover improvements needed to ensure a stable infrastructure; integration was hampered by a lack of computing devices for administrators, curriculum specialists, and technology personnel; and facilities were not provided to secure and charge devices. Training provisions failed to take into consideration the large number of schools involved and the added classroom obligations placed on technology integration specialists at the local level. At a ratio of nine regional mentors to 241 middle schools, state-provided support was minimal; in addition, professional development supplied to teachers averaged two days. Without the availability of an on-site, on-demand technology professional at the campus level, classroom technology integration, school-wide support, and consistent implementation was in jeopardy. Weston and Bain (2010) reiterated these concerns, citing numerous studies indicating low levels of one-to-one implementation and technology integration among MLTI teachers and varied levels of technology immersion at TIP schools. The MLTI also lacked an online central repository for information and resources. As the state pushed toward radical innovation within the schools, it failed to lead by example (Crystal, 2002).

Academic Impact of One-to-One Technology

Warschauer, Arada, and Zheng (2010) reported that the area showing the greatest impact of one-to-one laptop programs was student writing. Daily use of Internet-connected laptops indicated a rise in student research, stronger engagement in the writing process, increased
teacher-student feedback opportunities, and broader use of writing genres and formats. Gorder (2007) echoed those findings in his South Dakota study, stating that an increase was seen in specific content areas, including written work of greater length and quality.

Littleton Public Schools built a writing-centered one-to-one program that provided individual laptops to students in all English language arts classes for grade levels 5 through 10. Their program, titled Inspired Writing, deemed writing to be a critical component of learning across the curriculum. Through the one-to-one mobile computing design, students were exposed to a variety of writers and their works, interacted with peers through conversations about writing, conducted peer reviews, published their works in an array of formats, and utilized real-time collaborative writing. In their research on the writing program, the authors analyzed student blog comments and identified six overarching themes: tools for better writing, access to information, share and learn, self-directed learning, remaining relevant in a technological world, and engagement with new media. Responses in each theme solidified the authors’ view that students should be viewed as real writers who write with authenticity for a variety of purposes and audiences (Warschauer, Arada, & Zheng, 2010).

In an effort to understand the MLTI’s impact within the first five years of implementation on academic achievement and preparedness of 21st Century Skills, the Maine Education Policy Research Institute followed up with a series of evaluative studies. The writing component examined student and teacher perceptions of writing growth and student achievement on Maine’s state writing assessment as a result of Maine’s laptop program. Both teachers and students reported a positive impact as a result of the one-to-one initiative, indicating an increased amount of work was completed, at an increased speed, and at a higher level. The evaluative study also examined the middle school students’ writing scores on the Maine Educational Assessment
(MEA) during the 2000 school year, the year prior to one-to-one implementation, and again during the 2005 school year, five years after implementation. The results of the study were two-fold. First, writing scores showed an effect size improvement of .32, signifying the average student scored at a higher level than an estimated two-thirds of students taking the MEA during the 2000 school year. Second, the results indicated that the number of students meeting the state writing proficiency standard increased from 29.1% in 2000 to 41.4% in 2005. The evidence gained through the analysis supported the study’s conclusion that students were better writers due to participation in the one-to-one initiative (Silvernail & Gritter, 2007).

According to Zucker’s 2009 study, The Denver State School of Science and Technology experienced similar success in the area of writing; however, the most notable impact of the one-to-one program occurred in the area of assessment, with students’ test scores “among the highest in the state, and every graduating senior accepted to a four-year college or university” (p. 18). Zucker pointed out that this was especially notable given that the school was a public charter school with 40% of its student population designated as low-income (Zucker, 2009). Vail School District was another district that benefited according to the assessment process. Increased scores through the technology initiative earned it the distinction of being one of the highest-achieving districts in Arizona (Demski, 2011).

Classroom Benefits of One-to-One Technology

The impact of technology immersion through one-to-one efforts emerged in numerous studies. Gorder (2007) stated that preliminary feedback from South Dakota’s Classroom Connection initiative indicated a multitude of benefits, including increased student engagement and motivation, improved student-teacher relationships, increased student performance,
increased attendance, and decreased discipline referrals. Zucker (2009) noted an increase in student participation through online discussions. This format proved especially beneficial for those students less assertive in the classroom; likewise, the individual postings allowed teachers an opportunity to better assess student understanding and provide immediate feedback.

According to Bebell and O’Dwyer (2010), access to one-to-one technology showed a marked difference in student outcome and teacher practices, including increases in both student engagement and interest level. The authors stressed that the real gain “is not the mastery and success of the said technology, but the improvement of the process and environment in which teaching and learning occur” (p. 12). Reports on one-to-one initiatives in Chesterfield and Southern Columbia school districts showed that the infusion of technology tools proved advantageous, as both districts quickly garnered dramatically improved scores on standardized testing. The districts’ school leadership stressed a comprehensive approach to technology integration as key to implementing and fostering technology-rich learning environments (Fox, 2009).

Villano (2006) reported that initial results found on the eTxiP evaluation of the Texas one-to-one initiative showed a significant, positive impact on student attitudes, behavior, and disciplinary actions. In addition, Givens (2007) noted an increase in parental involvement and community support as well as an increase in student responsibility and motivation, greater teacher collaboration, increased student engagement, and fewer discipline problems. O’Hanlon (2007) reiterated Villano’s findings on TIP and reported similar benefits through his studies of MLTI, FLT, and Cincinnati Country Day School. Advantages included greater technical proficiency for students and teachers, greater collaboration, increased student engagement, and stronger parent participation and communication. Warschauer (2005) examined the increased
presence of project-based work, as a result of one-to-one computing, and found that students were inclined to dig deep as they accessed information, analyzed it through multiple perspectives, created authentic products, and used critical inquiry as a means toward obtaining 21st century learning skills. Gorder (2007) reported an overall improvement in digital-literacy skills, thinking skills, and communication skills. Wagnon, Chesterfield County’s district technology director, may have stated the improvement best: “We believe the laptop technology served to enhance student motivation, resulting in a more productive learning environment” (Fox, 2009).

Wallis, the head of creative arts at Sidcot School in North Somerset, United Kingdom, stated, “Creative teaching is a leap of faith” (Riddle, 2011). Riddles noted that one of the greatest benefits of a technology-rich learning environment is the creativity and imagination infused into the learning experience. Schaffhauser (2011) added that classrooms become student-directed learning environments focused on personalized education. The technology integration transforms the classroom into a community of learners in which learning holds relevance.

Many of these one-to-one initiatives are still considered to be in their early stages of application. Despite funding cuts, some districts have found immense value in their programs and have established creative ways to continue the large-scale technology integration. O’Hanlon (2007) quoted TEA’s Anita Givens as saying, “A lot of school districts are looking into incorporating technology spending into school bond initiatives” (para. 34). Likewise, monitoring and evaluation must be continued and ongoing to provide the much-needed information used to measure efficiency and effectiveness.
Technology Immersion Pilot (TIP)

Under the direction of the Texas Education Agency, the Technology Immersion Pilot (TIP) was created by the Texas Legislature in 2003 and set forth a statewide vision for technology immersion in public schools. The pilot was a result of Senate Bill 396 and was initially driven through approximately $14 million in federal Title II, Part D technology-related funds. Four years later, TEA used more than $20 million in federal Title II, Part D monies to fund the non-funded legislative mandate (Shapley et al., 2006; Shapley et al., 2007; Shapley et al., 2008; Shapley et al., 2009).

TIP was founded on the belief that technology integration in Texas public schools could be better accomplished through a total immersion of technology rather than the gradual introduction of each necessary component over time. As a result, a technology-rich environment would increase teachers’ technology proficiency and productivity while adding intellectual rigor to the classroom and lessons. Students would benefit from immersion through increased technology proficiency, content-based lessons that utilized timely and relevant learning experiences, opportunities for academic collaboration with peers, and increased motivation and engagement in the learning process. Teacher performance would be heightened, teacher retention rates boosted, school-to-parent communication strengthened, and parental and community involvement increased. The changes produced through technology immersion would ultimately contribute to increased student academic performance as measured through the state’s annual standardized assessments (Shapley et al., 2009; Texas Education Agency, 2010).

Over the course of the four-year pilot, three cohorts were selected. The first cohort was comprised of 42 Texas middle schools, Grades 6-8. Of the original 22 schools selected, 21 participated and served as treatment schools. An additional 21 were chosen as control schools.
Through a competitive grant process, schools were drawn from across the state and reflected rural, suburban, and urban locations. The student population at each school averaged 400 students, with enrollments ranging from 83 to 1,447 students. Two-thirds of the participating schools represented small or very small Texas districts of less than 3,000 students, with the other third representing large districts of 10,000 or more students. The grant’s high-need qualification resulted in 67% of the student enrollment classified as economically disadvantaged.

Demographic data showed a diverse student population with approximately 58% Hispanic, 7% African American, and 36% White (Shapley et al., 2009).

In order to ensure consistency, the state issued a Request for Qualifications (RFQ), which allowed commercial vendors the opportunity to become providers of the technology immersion packages. Technology immersion involved six major components: a laptop for every student and teacher, wireless access throughout the school, online curricular resources, online assessment resources, professional development, and ongoing technical support. Vendors were required to incorporate each component into their plan. Three vendors were chosen: Dell Computer, Inc., Apple Computer, Inc., and Region I Education Service Center (Shapley et al., 2006; Shapley et al., 2007; Shapley et al., 2008; Shapley et al., 2009).

Theories and Framework

Fundamental to the establishment of TIP was the belief that technology immersion provides a means to create classroom environments that heighten both teaching and learning through meaningful, relevant, and intellectually stimulating learning experiences (Shapley et al., 2009). This idea hinges on quality implementation made effective through robust access to technology, technical and pedagogical support, professional development, and curricular and
assessment resources. These components align with the *Texas Long-Range Plan for Technology, 1996-2010*, which identified four major domains essential to the successful integration of technology: teaching and learning; educator preparation and development; leadership, administration, and instructional support; and infrastructure for technology (Shapley et al., 2006; Shapley et al., 2009). The creation of TIP through Senate Bill 396 advanced the state’s technology vision with an emphasis on lifelong learning, effective communication, creativity, and engagement as a means toward realizing student success and productivity (Shapley et al., 2009).

Critical to increasing student academic achievement through technology integration and the one-to-one mobile computing innovation is knowledge of the engagement theory. This theoretical framework is in line with the fundamental goals outlined in the theory of technology immersion through one-to-one mobile computing devices. Engagement theory is a synthesis of several established theories, with strong ties to the constructivist theory and has served as the foundation for the one-to-one laptop initiative (Donovan et al., 2010; Kearsley & Shneiderman, 1999; Murphy et al., 2007; Smythe, 2011). The major premise is that for student learning to be both effective and successful, active engagement must occur. The engagement theory is especially timely and appropriate as schools across the country struggle to meet NCLB’s accountability challenges and college and career readiness standards. The pedagogical changes influenced by one-to-one laptop initiatives permit student learning to go beyond the scope of the classroom and allow students to transfer specific activities within each component to college and career levels (Kearsley & Shneiderman, 1999; Spires et al., 2011). The additional step reinforces the use of technology as a means to successfully construct knowledge through a connection to relevant real-world situations (Murphy et al., 2007; Swan, Van ’t Hooft, Kratcoski, & Schenker,
The use of technology as a communication tool allows for a heavy emphasis on collaborative efforts, synthesis of information through project-based assignments, creativity, problem solving, and meaningful, purposeful learning (Kearsley & Shneiderman, 1999). The role of the teacher in partnership with the student in the learning process thereby increases student ownership and control, produces opportunities for successful knowledge and skills acquisition, and motivates students to find meaningful connections. The result is an authentic learning environment where students are motivated to acquire knowledge, create tools, solve problems, and use critical thinking skills to achieve a common goal of improved student outcomes (Chessler, Rockman, & Walker, 1998; Fairman, 2004; Henríquez & Riconscente, 1999; King, 2002; Li, 2010; Windschitl & Sahl, 2002).

Technology Immersion Pilot Components

As a means to foster uniformity among the 22 schools selected for participation, the Texas Education Agency (TEA) disseminated a Request for Qualifications (RFQ) outlining the TIP’s six required components. Through the RFQ format, commercial vendors applied to become providers of the pilot’s packages (Texas Education Agency, 2003). The components were grounded in the technology immersion model, which assumes that for technology to be used effectively within the classroom, schools must provide access to robust technology, technical and pedagogical support at both implementation and ongoing stages, continued professional development, and readily available curricular and assessment resources (Shapley et al., 2007). The six components included a wireless computing device for each educator and student to provide anytime-anywhere technology access; software encompassing productivity, communication and presentation features for use as learning tools; online instructional resources
to support the state curriculum in the four core areas of English language arts, mathematics, science, and social studies; online assessment tools to identify student strengths and weaknesses as well as monitor progress toward student mastery of the core curriculum; professional development for teachers to assist in the integration of technology in the classroom; and both initial and ongoing technology support.

As a means of determining fidelity of implementation, an envisioned “ideal” was determined using seven immersion components. Five of the components supported implementation through leadership, teacher support, parent and community support, technical support, and professional development. The two remaining components related to teacher and student implementation outcomes through classroom immersion and student access and use (Shapley et al., 2008).

Wireless Mobile Computing Devices

Advancements in technology, along with the use of digital media, expanded portability, and changes in social networking, have created a unique learning environment. Wireless infrastructures and mobile multimedia devices allow for immediacy and on-the-go connectivity, and social interaction has provided the foundation for a new level of collaboration. The portability and multimodal features of personal computing devices extend beyond delivery of information. Communication and collaboration components allow students to construct knowledge through meaningful, relevant learning (Norris & Soloway, 2008). In addition, an abundance of applications and software put the tools and resources in learners’ hands in new and varied forms. The popularity and rapid growth of one-to-one learning has increased the availability of personal handheld devices. Smart phones, laptops, and ebooks provide
spontaneous and individualized learning that gives the learner the ability to connect to the world at a moment’s notice (Liu & Milrad, 2010).

Reducing the high student-to-computer ratio through increased access to computing devices is critical to increased technology and the development of 21st Century Skills (Shapley et al., 2006). Despite Texas’ goal of providing every student with one-to-one access to Internet-connected devices, economic inequities have created challenges in meeting this goal, especially for economically disadvantaged and minority student populations. While the Internet access and technology gap has lessened between higher and lower poverty schools, the income-related gap continues. Results have shown that low-income students have fewer opportunities compared to their advantaged peers to develop technology skills, and minority and economically disadvantaged students are less exposed to technology outside of the school (Shapley, Benner, Heikes, & Pieper, 2002).

In order to counteract the educational gap produced through adverse economic conditions, technology immersion creates a one-to-one technology environment with computing device access for every student (Shapley et al., 2007). Teachers involved in the Classroom Connections initiative maintained that the opportunity for student access to mobile computers positively impacted the classroom (Gorder, 2007). For Arizona’s Vail Independent School District, one-to-one computing was critical to its Beyond Textbook all-digital curriculum initiative. Despite financial concerns, the district expanded the technology initiative across campuses, implementing the one-to-one through a bring your own device program open to any web-enabled device, including laptops, PDAs, iPod Touches, and cell phones (Weinstock, 2010).
Software

The immersion of technology through one-to-one computing provides students with digital learning opportunities as a means to more engaged, relevant, and personalized learning. In order to successfully support the state curriculum, immersion resources modify existing instructional practices through productivity, communication, and presentation software. Learning becomes interactive, and students gain knowledge through doing. Digital learning affords students the ability to gain more information, visualize complex concepts, and extend learning. As a result, digital learning redefines educational opportunity, and one-to-one devices serve as tools for both learning and teaching (Shapley et al., 2006; Shapley et al., 2007).

Although limited funding has forced many districts to think outside the box in addressing both software and hardware issues, the addition of cloud computing has proven to provide financial benefits and learning experiences that level the playing field for all students regardless of location and/or finances. As Siegle (2010) stated, “Educators need to embrace this trend in technology as they develop students’ talents and expand their students’ understanding of a world that lies in wait at their fingertips” (p. 45). Cloud computing, as defined by Siegle (2010), utilizes the Internet and remote servers to deliver and store data and applications. Remote access allows users direct contact to applications without the cost of installation or the required hardware to save information. The cost savings in both infrastructure and software is of economic benefit to school districts. Even more advantageous is the anytime-anywhere feature that cloud computing provides to the user. The popularity and growth of cloud computing has decreased the consumer’s need for laptops with high-speed processors, massive memory, and large storage capabilities (Siegle, 2010). This in turn has reduced the price of laptops, making one-to-one computing a reality for a large number of schools.
Warschauer et al. (2010) reported that the availability of low-cost and free tools from cloud-based Google Apps reduced the overall program costs, allowing more schools to participate in one-to-one programs. Nevin (2009) reiterated those findings, explaining the importance and popularity of Google Apps in the world of cloud computing. Because access relies on a remote Internet server, the cost of application and storage is tremendously decreased, making cloud computing and Google Apps a viable alternative in the field of education. Google Apps offers students and teachers the same computer environment whether at home or school, which alleviates problems moving from one format to another. The ease of software use without costly installation provides automatic software updates, easy access and storage, anytime-anywhere capabilities, portability, publishable documents, PDA accessibility, and a strong collaborative tool. It provides for teacher feedback on assignments and assessments, and for group work capability that provides real-time sharing, automatic saving, and documentation of each group member’s contribution. Nevin (2009) maintained that the ease of use of this cloud-computing format has proven it to be a strong educational tool for both students and teachers.

Demski (2011) explained how Arizona’s Vail School District put the cloud’s tools into action through the Beyond Textbooks program, a common core standards-based curriculum program. Central to the program is the ability to electronically organize information, implement immediate updates, and provide teachers with easy accessibility through content specific subscriptions. At the student level, the ability to access the same program regardless of the device used is imperative to providing an equal playing field for all students. Browser-based programs such as Google Apps, Moodle, and It’s Learning provide “seamless” access to educational resources from any web-enabled computing device (Weinstock, 2010).
Instructional Resources

Successful implementation of technology within an immersion school depends on the availability of instructional and learning resources that support the state’s curriculum (Shapley et al., 2007). TIP’s immersion package represents an array of instructional resources, with each chosen to extend, supplement, or enhance core-content learning (Shapley et al., 2006). One-to-one initiatives increase meaningful uses of technology for student-centered, project-based learning. The integration of one-to-one mobile computing devices shifts the control within the classroom from the teacher to the student, allowing students to drive their own learning and embrace the opportunities provided through digital learning (Tech & Learning, 2012). Class time becomes more focused as student attention and motivation increases. Students participate in more research-based inquiry through Internet integration and decreased forms of direct instruction. Additional support and guidance is present during the learning process as teachers become facilitators in learning and lessons become more student-centered and constructivist in nature. The technology design provided through one-to-one platforms allows for more individualized, differentiated instruction and higher order thinking thereby transforming schools into learner-, assessment-, community- and knowledge-centered learning environments (Cavanaugh et al., 2011; Donovan et al., 2010; Dunleavy & Heinecke, 2007; Fairman, 2004).

Online Assessments

The implementation of digital resources through one-to-one mobile computing extends beyond the lesson to both formative and summative assessment capabilities. Through technology immersion, teachers are provided student data and the resources needed to diagnose student strengths and weaknesses within their specific academic areas. The real-time aspect of
one-to-one technologies allows for timely, relevant feedback and the information needed to assess student progress toward mastery of the state curriculum (Shapley et al., 2006; Shapley et al., 2007).

Professional Development

Professional development is critical to building teachers’ capacity to adapt to the changes created by emerging technologies. The rapid pace and influx of new technologies requires pedagogical insight and ongoing education if educators are to reap the technical and pedagogical benefits of newly developed technology. Professional development is also critical to the application of this technology and to the academic improvements needed to reach state and federal educational standards (Bubb & Earley, 2009; Cavanaugh et al., 2011; King, 2002; Norris & Soloway, 2008; Shapley et al., 2007).

Teacher education programs recognize the increased use of one-to-one computing programs and realize the need for pedagogical support prior to teacher placement within the classroom. An awareness of faculty readiness and preparation is important in the planning, support, and pacing of the implementation of the innovation. Support and collaboration, especially with regard to teachers’ personal concerns of technology proficiency, are central to providing teachers with the foundation necessary for one-to-one integration (Donovan & Green, 2010).

Transformational learning verifies that professional development works most effectively when it allows the learner to not only learn how to use the tools but also learn how to apply and integrate their use within the curriculum (Dunleavy, Dexter, & Heinecke, 2007; King, 2002; Spires et al., 2011). TIP echoed that philosophy by requiring the classroom support component
to include modeling, coaching, or mentoring (Shapley et al., 2006). One-to-one initiatives viewed first as educational programs versus technology programs require pedagogy, professional development, and collaboration to move to the forefront (Warschauer, 2005). The use of professional learning communities with hands-on collaborative collegial support moves teachers beyond the structure and formality of traditional professional development to become effective facilitators of the change process (Dufour & Baker, 1998). Changes created through student learning and pedagogical practices both multiply and magnify as awareness of resources increases and greater understanding of the innovation evolves, offering a capability for successful implementation far more pervasive and permeable than any past large-scale technology initiative (Bubb & Earley, 2009; Cavanaugh et al., 2011; Li, 2010). Through sustained professional development and district- and school-level support, teachers’ receptiveness to technology integration within the classroom is increased, ultimately driving the implementation of the innovation toward whole school improvement (Boardman & Woodruff, 2004; Bubb & Earley, 2009; Cavanaugh et al., 2011; Dunleavy et al., 2007; Garet, Porter, Desimone, Birman, & Kwang, 2001; King, 2002; Schrum, Burbank, Engle, Chambers, & Glassett, 2005).

According to Gorder (2007), professional development proved imperative to the success of the Classroom Connections initiative. She described several formats used by districts, including a three-phase training that focused on technology and applications, content development, and engagement activities. “Advance Teams” composed of two teachers, the technology coordinator, and an administrator provided support for technical, pedagogical, and managerial issues within the program. Bebell and O’Dwyer (2010) drew from a theoretical review of Weston and Bain (2010) that suggested laptops should not be considered a technology
tool but instead a cognitive tool to be integrated into teaching and learning (p. 8). Riddle (2011) explained the relevance of technology skills for today’s learners and the impact these skills have on education and the instructional process. The traditional format to which so many are accustomed is no longer the preferred method of learning. According to Riddle, it is also not the way students learn best. Teacher buy-in and quality, in-depth professional development are essential to a successful one-to-one implementation (Bebell & O'Dwyer, 2010).

Davis, Southern Columbia Area’s secondary tech coordinator, explained that having a coach/mentor available for faculty training and support empowered the teachers (Fox, 2009). Catskill Central School District’s “Lunch and Learn” sessions allowed teachers the opportunity to become more informed and at ease with the technology. Other professional learning opportunities included summer events, symposiums, and share sessions (Gorder, 2007). Forest Hills Local Schools’ instructional technologist Harrod noted that her district’s year-long professional development program was aimed at helping teachers become more comfortable and fluent with technology and more knowledgeable about web 2.0 offerings. She explained that the focus was instructionally based stating, “This isn’t about the technology anymore. It’s about shifting our notion of what instruction looks like in the 21st century” (Schaffhauser, 2011).

Givens, senior director for instructional materials and educational technology at the Texas Education Agency (TEA) noted that professional development was “the most important component” of TIP’s success (Villano, 2006). The Evaluation of Texas Technology Immersion Pilot’s (ETxTiP) annual findings supported Givens’ statement, noting a connection between higher levels of classroom and student immersion and the professional and pedagogical support provided to teachers. The stringent parameters established through the TIP grant required participating schools to provide support for immersion package components, technology-
enhanced learning opportunities and experiences, lesson development in the core subject areas, sustained learning opportunities, and ongoing coaching and support (Shapley et al., 2006). Despite the specificity of the grant, TIP provided local level flexibility in the design and delivery of the required support. The result was a wide variety of professional development offerings and an inconsistency in quality and training opportunities that hindered many of the teachers within the participating schools from achieving the technological and professional growth needed to create technology-rich classroom environments. A commitment by school leadership to technology and to the professional development needed to support changed practices proved imperative in influencing and achieving technology immersion (Shapley et al., 2006; Shapley et al., 2007). Likewise, the teachers’ attitudes and their involvement in professional development not only affected technology integration within the classroom, but also significantly impacted student access to technology and its use as a learning tool (Penuel, 2006; Shapley et al., 2007).

Technical Support

Although similar to other one-to-one mobile computing initiatives, TIP’s whole school immersion coupled with the concurrent provision of technical support made it unique in the world of one-to-one technology initiatives. The grant specified immersion packages provide campus-based technical support targeted toward advancing the effective use of technology for teaching and learning. In order to evaluate the technical support component, eTxCiP measured four indicators: technical support – staffing; technical support – problems; formal coaching and mentoring; and collegial support. Technical support was seen as an investment both valued and essential in order to assist teachers and students in the successful use of one-to-one technology. Therefore, the technical support feature required each participating middle school to have a staff
member assigned to provide internal pedagogical support for effective technology integration into the classroom instruction and curriculum (Shapley et al., 2006; Shapley et al., 2007).

Evaluation of the Texas Technology Immersion Pilot (eTxTiP)

In addition to TIP, a separate research project titled eTxTiP (Evaluation of the Texas Technology Immersion Pilot) was executed simultaneously through the U.S. Department of Education’s Evaluating State Educational Technology Programs federal grant program. The purpose of the second project was to scientifically evaluate whether technology immersion affected the academic achievement of middle school students over time as measured by the Texas Assessment of Knowledge and Skills (TAKS). The evaluative format of the eTxTiP study utilized a quasi-experimental scientific research design to administer a mix of both qualitative and quantitative methods to the participating middle schools. Each school was randomly assigned the status of an experimental school or a control school. The experimental school served as the technology-immersed site, which implemented the technology immersion model. The control school served as the non-immersed site (Lemke & Lesley, 2009; Shapley et al., 2006; Shapley et al., 2007; Texas Education Agency, 2010). The eTxTiP study became one of the largest, multi-year education technology research study, with hopes of serving as a guide for future state-conducted scientifically based evaluations of education technology initiatives (Lemke & Lesley, 2009). It examined the relationships that existed through contextual conditions, technology immersion, and intervening factors including school, teacher, and student achievement. The Texas Center for Educational Research (TCER) served as TEA’s primary partner in this landmark four-year educational endeavor (Shapley et al., 2006; Shapley et al., 2007; Shapley et al., 2006).
Over eTxTiP’s four-year study, three student cohorts were followed. Cohort 1, which began TIP’s inaugural year, encompassed the initial student group’s sixth through ninth grade school years. Cohort 2 began the following year and consisted of the incoming sixth grade student body. The study followed them for three years, focusing on their sixth through eighth grade school years. Cohort 3 began the third year of the study and followed the incoming sixth grade student group during their sixth and seventh grade school years (Shapley et al., 2009).

The mixed method quasi-experimental research design utilized in the project employed a comparison of treatment and control schools. Site visits were conducted at each middle school campus beginning in the fall of 2004 and continuing through spring 2008. Single and paired observers conducted observations. In general, all core-content teachers were observed on small campuses with a representative sample of classrooms used on larger campuses. The analytical sample for eTxTiP’s four-year study included 2,137 teachers who taught at participating TIP schools at some point within the time period (Shapley et al., 2009). Information was gathered through interviews and focus groups (Texas Education Agency, 2010) as well as annual online teacher surveys, paper-and-pencil student surveys, and individual schools’ disciplinary action reports. In addition, school and student data were collected annually from TEA through the Texas Public Education Information Management System (PEIMS) and the Academic Excellence Indicator System (AEIS). This comprehensive method allowed inferences to be drawn regarding the causal effects of technology immersion (Shapley et al., 2009).

In order to meet eTxTiP’s primary goal of measuring the long-term effects of technology immersion on middle school students’ academic achievement, three hierarchical linear models (HLM) were used to examine mathematics and reading test scores of students in each of the three cohorts. This process provided the statistical tools to study rates of change at five time points.
beginning in fall 2004 and continuing through spring 2008. TAKS scale scores were converted to T scores with a mean of 50 and a standard deviation of 10. The HLM growth modeling estimated the effects of immersion on cumulative growth in T-score units for both the treatment and control groups, the mean cumulative growth differences between the two groups, and the estimated sizes of the effects in deviation units. Two-level HLM models were used to analyze associations between the strength of implementation of technology immersion and students’ TAKS achievement. In addition, the use of the HLM linear models provided information on the effects of immersion on teachers’ and students’ perceptions of their technical proficiencies and technology use.

eTxTiP’s Findings

Five key research areas were targeted through eTxTiP: the effect of technology immersion on teachers and teaching, the effect of technology immersion on students and learning, the effect of technology immersion on students’ academic achievement, the level of implementation of technology immersion, and the relationship between implementation and student academic outcomes. The outcomes reported in the evaluation represent technology immersion across multiple years of implementation and multiple cohorts. The level of immersion among TIP school participants generally reached less than full implementation (Shapley et al., 2009).

Technology Immersion on Teachers and Teaching

The study found that technology immersion teachers displayed increased technology proficiency in both technology operations and pedagogical skills. An increased use of
technology for professional productivity was observed in addition to a more rapid pace of
technology integration within the classroom. Teachers in the experimental group indicated
stronger, positive ideological associations with technology integration and learner-centered
practice, including authentic problem solving, critical thinking, learning goals, and experiential
learning. Immersion teachers also revealed less resistance to technology integration, resulting in
a significant increase in student use of technology applications for core-content activities.
Researchers used the Observation of Teaching and Learning (OTL) instrument to better
understand teachers’ instructional practices. Areas observed ranged from classroom organization
and student engagement to questioning strategies and student engagement. The components
introduced through technology immersion affected teachers’ perceptions of the school’s culture,
involving technology leadership, parent and community support, and innovation. The
experimental group exhibited increased professional collaboration and higher levels of collegial
interaction that supported technology integration within instructional practice. School poverty
showed a negative association to teachers’ professional growth, technology proficiency, and
student use of technology applications for both control and treatment schools. The study
indicated a general lack of intellectually challenging lessons across all middle school campuses;
however, the researchers’ classroom observations suggested a slight increase in intellectually
demanding work within the technology-immersed schools (Shapley et al., 2009).

Technology Immersion on Students and Learning

The study found that both economically advantaged and economically disadvantaged
students immersed in technology showed greater proficiency in mastering the Texas Technology
Application standards as opposed to those students in non-immersed schools. Economically
disadvantaged students reached levels of technical proficiency that equaled proficiency levels of the advantaged students enrolled in the control schools. The yearly analysis revealed that technology-immersed students used technology applications more frequently in core-content classes, with increased opportunities for collaboration among peers in small-group activities (Shapley et al., 2009).

Researchers used the Student Questionnaire and the Style of Learning Inventory (SLI) to measure the effects of technology immersion for six scales: classroom activities, small-group work, technical problems, technology proficiency, self-directed learning, and school satisfaction. Despite expectations set forth in the technology immersion model that anytime-anywhere learning would motivate technology-immersed students to become more self-directed in their learning and find increased satisfaction and relevance in the learning process, researchers found no evidence of increased student self-directed learning and less satisfaction with meaningfulness and relevance in learning across all middle school students. The trend continued as both control and immersion groups progressed to higher grade levels (Shapley et al., 2009).

The student-level data of schools on disciplinary actions and school attendance rates were reviewed as indicators of immersion effects on student engagement. Fewer disciplinary problems were reported among the treatment group than the control group, resulting in less time spent by teachers and administrators on disciplinary issues and more students remaining in the classroom. The first three years of the evaluation found lower attendance rates among students at technology-immersed schools in comparison to control students. The fourth-year analysis found a smaller, statistically non-significant difference in attendance rates between the two groups. However, the modestly lower average in school attendance did not correlate with lower academic achievement (Shapley et al., 2009). The study noted the importance of the findings in
relation to the expectation that improved school and classroom conditions through the use of
technology immersion will bring higher technology proficiency levels and increased use of
technology in conjunction with more intellectually demanding and meaningful school work,
ultimately increasing student learning and engagement (Shapley et al., 2009; Shapley et al.,
2006).

An additional finding in this area related to increased technical problems with devices as
they aged over the four-year period. As each cohort entered the program, students often
inherited used laptops. By the fourth year, technology-immersed students reported technical
problems at twice the rate of those at non-immersed schools. The age and deterioration of one-
to-one devices added to the demands and workloads of an already busy technical-support staff
(Shapley et al., 2009).

Technology Immersion on Academic Achievement

The Technology Immersion Model assumes that immersed schools provide their students
with school and classroom experiences that promote individualized learning, rigorous classwork,
and increased levels of engagement, resulting in increased academic performance as measured
on the annual TAKS reading and mathematics state assessments. Through data provided by
TEA, passing and commended rates were reviewed to identify student progress toward meeting
the specified state standards. TAKS scale scores were converted to T scores with a mean of 50
and a standard deviation of 10. The “value added” methodology of HLM was then used to
estimate the effects of technology immersion on students’ academic achievement. The
longitudinal information available on student achievement through TIP’s three cohorts gave
researchers the data needed to evaluate the program by examining group differences and
replication across cohorts and outcome measures. Although there was no statistically significant effect on reading achievement for Cohort 2 and 3, a statistically significant and positive sustaining effect was indicated for Cohort 1, which had been involved in technology immersion during the entire three-year middle school period. The economically disadvantaged students within Cohorts 1 and 2 increased in reading achievement at a faster rate than their economically advantaged peers. Results disclosed a small but continual increase in TAKS reading the longer students were exposed to technology immersion. Academic growth in mathematics for economically advantaged students in Cohorts 2 and 3 notably outpaced control groups across years. Likewise, positive academic growth was cited for immersed schools’ economically disadvantaged students. Cohort 1 saw a positive but statistically non-significant effect of technology immersion between the immersed group and the control group (Shapley et al., 2009).

Due to the fact that students are not tested in social studies, science, and writing every year, it is difficult to draw conclusions about the effects of technology immersion. The information available showed no statistically significant difference in any of the three areas between the two comparison groups; however, writing scores have consistently proven more advantageous for the control group. This finding may be due in part to the paper-and-pencil format of the TAKS writing test, which fails to take into consideration the writing performance of technology-immersed students who use word processing for written work (Shapley et al., 2009).

Student access and use, in particular the use of one-to-one devices outside of school for core-content homework and learning activities, proved a strong indicator of student academic performance on TAKS reading and math tests. Cohorts 2 and 3, while not statistically significant, proved to be consistently positive. Specifically, Cohort 2 showed a positive but not
statistically significant indicator for academic success in reading and a positive and marginally significant predictor in math. Cohort 3 was a positive and statistically significant predictor in both TAKS reading and math. The information identified within this area is important in understanding the role one-to-one devices play in providing learning experiences to economically disadvantaged students with limited out-of-school learning opportunities. The ubiquitous laptop format and the availability of online textbooks allow teachers to extend learning and encourage students to continue their work beyond the school walls (Lemke & Lesley, 2009; Shapley et al., 2009). These findings were supported in the 2008 Progress Report on the Long-Range Plan for Technology, 2006-2020, which reported students at technology-immersed schools used their devices extensively at school and at home. Students showed greater and more timely access to informational resources, increased production of complex and rigorous projects in core-content classes, and improved technical skills, leading to positive student achievement (Texas Education Agency, 2008).

The Level of Implementation of Technology Immersion

Successful implementation of technology immersion hinges on having the necessary support in place. Given strong school leadership, stakeholder support, technical support, and professional development, teachers’ technology integration and student access and use proved robust. However, immersion showed only slight annual increases while student access and use declined. ETxTiP found that additional support was needed in the areas of parent and community buy-in as well as technical support and professional development. As a result, only a quarter of the participating schools reached substantial levels of technology immersion by the end of the fourth year. A majority of the schools’ core teachers attained only partial levels of
classroom immersion by the fourth year, and a fifth of the schools’ teachers exhibited substantial levels of classroom immersion. The largest gain was in professional productivity, while classroom integration accounted for the least amount of change. Student access and use declined annually across the four-year period. The study identified a number of factors which could have attributed to the decline, including the increase in technical problems due to aging of the devices, the transfer of one-to-one devices from individual students to classroom sets, district-imposed restrictions on the use of laptops outside the classroom, and teachers’ acceptance or rejection of the innovation and the need for instructional change (Shapley et al., 2009).

In examining implementation, evidence found a wide variation in implementation across the participating middle schools and their classrooms, with only one quarter of the schools reaching levels of technology immersion nearing full implementation after four years of involvement in the pilot program. Through site visits, researchers noted that a large number of TIP participants viewed the lack of a start-up year for planning, collaboration, and training as a barrier to effective implementation. Schools that experienced higher implementation levels viewed committed school leadership as integral to their success. While “high expectations” for technology integration were conveyed from the top, teachers were given the time and opportunity to buy in to the program, provide input, and establish a collegial culture for professional growth. The process enhanced teacher learning and promoted instructional change, leading to improved student learning experiences. Schools that failed to meet full implementation standards noted administrative turnover, teachers who lacked buy-in due to a myriad of concerns and frustrations, a lack of initial and ongoing professional development opportunities, poor wireless Internet infrastructures and insufficient technical support, and concerns regarding the management of laptops (Shapley et al., 2009).
Researchers also examined the sustainability of technology immersion at participating campuses and found that respondents relied heavily on administrative leadership and planning, considered critical to the continuation of their schools’ one-to-one programs. The commitment of leadership to providing long-range planning, financial resources, professional development, and technical support was viewed as imperative to the process of continued implementation. 

Leaderships’ commitment, and ability to communicate technology’s role in promoting digital learning environments, was believed to be important to sustaining technology-immersed campuses as a means to expand student learning and prepare students for the 21st century workplace. Several respondents felt implementation should take place incrementally a grade level at a time toward full immersion. School-wide implementation, as the ultimate goal, would promote vertical as well as horizontal instructional alignment and collaboration. Some schools believed a reconfiguration of technology use was needed, moving devices from individual use to classroom sets and restricted to in-school use to minimize deterioration and ensure all students had access to technology within the classroom. Researchers concluded that the change required for full technology immersion necessitated a change in school culture and in long-held mindsets about the nature of teaching and learning. Innovative school reform efforts through ubiquitous learning required a long-term commitment by administration, faculty, parents, and students and state support to effectively meet districts’ and schools’ varied technology initiatives (Shapley et al., 2009; Texas Education Agency, 2010).

The Association between Implementation and Academic Outcomes

In determining the relationship between implementation of technology immersion and students’ academic achievement, the study examined immersion support, classroom immersion,
and student access and use. The four-year analysis found the mean immersion scores to show small annual increases among the three implementation components. The campus measure of immersion support, which included leadership, stakeholder support, and professional development, in conjunction with the reading and mathematics teachers’ reported levels of technology integration within the classroom, were found to be inconsistent predictors of students’ academic achievement on the TAKS reading and mathematics tests. Although not statistically significant, the level of student access and use of technology steadily proved to be a positive predictor of student performance in the two content areas. Student access and use targeted three layers of implementation: laptop access days, core-content learning, and home learning. Within these three components, students’ use of their laptops for home learning in the core-subject areas was the strongest implementation predictor of TAKS reading and math performance. Cohort 2 reported home learning as a positive but non-statistically significant predictor for reading success and a positive, marginally significant predictor for mathematics success. Cohort 3 reported home learning as a positive and statistically significant predictor of achievement for both TAKS reading and mathematics (Shapley et al., 2009).
CHAPTER 3

METHODOLOGY

The relationship between technology immersion through one-to-one mobile computing and student academic performance, as measured by reading and math state assessment scores, is of important interest to school districts as they maneuver state and federal accountability systems. The review of literature reveals the power one-to-one mobile computing holds in customizing student learning and engaging students as digital learners. Research also indicates that numerous mobile device initiatives have failed to show consistent success in the implementation, economic efficiency, and academic effectiveness within their respective one-to-one mobile computing programs. Despite the lack of clear-cut evidence-based research on the academic benefits of one-to-one mobile computing, current literature is clear that as technology advancements continue to evolve, technology immersion through one-to-one mobile computing plays a role far greater than a means toward increased test scores.

Research Design

The quasi-experimental framework for this study used linear and logistic regression models to examine the impact of one-to-one mobile computing on academic performance of a student group within a rural Title I school district. The one-to-one mobile technology initiative was initially implemented through the Texas Education Agency (TEA) sponsored Technology Immersion Pilot (TIP). This study followed a group of individual students over an eight-year period from their third grade year through graduation. An interrupted time series design was employed within the study to examine the students’ available state assessment scores in reading and math during that time period. The research design allowed for an in-depth analysis of the
implementation and sustainment of the one-to-one mobile technology as an intervention during the group’s sixth grade school year. Of interest were the changes over time based on the Texas Assessment of Academic Standards (TAAS) and the Texas Assessment of Knowledge and Skills (TAKS) scores among the same group of students within the eight-year period. The use of state assessment data, made available by the selected school district, before implementation of the intervention, during implementation, and after implementation provided added confidence regarding the effectiveness of the intervention. Analysis was required to determine the effectiveness of the intervention (Gay & Airasian, 2003). Evidence for causality in this quasi-experimental research design was supported by the collection of longitudinal data from the same participants, data on dependent variables at the beginning of the study, and the use of a piecewise growth model (Johnson, 2001).

Growth models -- in particular, piecewise growth models -- have become a valued tool in establishing academic progress and educational accountability. The restraints of NCLB’s accountability standards and the implementation of federal initiatives, including Race to the Top, have prompted schools to review methods for monitoring school performance. Educators agree that the use of performance indicators through student proficiency percentage calculations and a mean school performance is not an efficient and accurate measure of student progress and school performance. Numerous states are moving toward the use of growth models as a method of providing a more exact report of students’ educational progress, school effectiveness, and educational accountability (Auty & Brockmann, 2012; Goldschmidt, Choi, & Beaudoin, 2012). Growth models summarize student performance over two or more time points. In doing so, the compilation of definitions, calculations, or rules that result from the summaries support decisions about students, including their classrooms, teachers, and schools (Castellano & Ho, 2013). The
format of this model allows the evaluative tool to move past the environmental and economic factors outside a school’s control by focusing on the change of student achievement over time (Auty & Brockmann, 2012; Goldschmidt et al., 2012).

A wide variety of growth models exist, and while stakeholders look for an optimal model to show evidence of increased student growth, the outcome may prove the opposite. The context in which the model is used and the identification of a clear purpose is critical to formulating a valid inference of academic performance, especially in overcoming the complexities of varied state assessments, testing practices, and both student and school characteristics. An understanding of the data in relation to the trajectories and correlations is needed. The stability of the model’s implementation is imperative to the credibility of the accountability system; therefore, a level of confidence is required to assure that growth is consistently measured over time and that the growth measured reflects actual school processes (Auty & Brockmann, 2012; Goldschmidt et al., 2012).

The piecewise growth model, which was used in this study, is valuable in examining the impact interventions play on student academic progress over time. The model’s framework estimates a mean rate of growth trajectory for individual students and identifies variations in academic progress across individuals for meaningful periods or segments of time within the intervention’s use. As this study moved through the pre-intervention, intervention, and post-intervention periods, key correlates were obtained, including variances in implementation, student demographics, and factors required for sustained growth (Seltzer & Svartberg, 1998).
Research Questions

The following research questions were developed to guide this study:

1. Does the implementation of technology immersion through one-to-one mobile computing devices impact the reading performance of students in a selected rural Title I public school district over time?

2. Does the implementation of technology immersion through one-to-one mobile computing devices impact the math performance of students in a selected rural Title I public school district over time?

Participants

Participants of this study included 70 students who were enrolled as third graders in a selected Texas public school during the 2001-2002 school year. During fall 2004, the students were sixth graders and participated within their middle school as participants in Cohort I of Texas’ TIP one-to-one technology immersion study and the eTxTiP evaluation process. Table 1 shows the demographic distribution of the study’s sample. Among the participants, 67.1% of students were economically disadvantaged, with 57.1% qualifying for free lunch and 10% for reduced-price lunch. For this study, Title I relates to economically disadvantaged. The Texas Education Agency defines economically disadvantaged as receiving free or reduced-price school lunches or receiving other public assistance.
Table 1

Economically Disadvantaged Distribution of Study Participants

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<th>Cumulative Percent</th>
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<tr>
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<tr>
<td>Reduced</td>
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<td>100.0</td>
</tr>
<tr>
<td>Total</td>
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<td>100.0</td>
<td>100.0</td>
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</table>

Table 2 shows the gender distribution of participants within this study. Data shows the majority of the study’s participants were female (54.3%).

Table 2

Gender Distribution of Study Participants

<table>
<thead>
<tr>
<th></th>
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<th>Percent</th>
<th>Cumulative Percent</th>
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<td>54.3</td>
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<tr>
<td>Male</td>
<td>32</td>
<td>45.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3 displays the ethnic distribution of the participants within the study. The disaggregation of data indicates the majority of the study’s participants self-identified as Hispanic (65.7%).
Table 3

_Ethnic Distribution of Study Participants_

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Hispanic</td>
<td>46</td>
<td>65.7</td>
<td>70.0</td>
</tr>
<tr>
<td>White</td>
<td>21</td>
<td>30.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 shows the distribution of Limited English Proficiency (LEP) status among the study’s participants. The results indicate the majority of students (94.3%) were not identified LEP.

Table 4

_Limited English Proficiency Distribution of Study Participants_

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not LEP</td>
<td>66</td>
<td>94.3</td>
<td>94.3</td>
</tr>
<tr>
<td>LEP</td>
<td>4</td>
<td>5.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 shows the at-risk distribution of the study’s participants. At-risk information shows the majority of students (60%) were at-risk.
Table 5

At-risk Distribution of Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not At-risk</td>
<td>28</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td>At-risk</td>
<td>42</td>
<td>60.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 shows the special education distribution of the participants within the study. The special education information shows the majority of students (97.1%) were not identified for special education services.

Table 6

Special Education Distribution of Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Special Education</td>
<td>68</td>
<td>97.1</td>
<td>97.1</td>
</tr>
<tr>
<td>Special Education</td>
<td>2</td>
<td>2.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Information posted publicly through TEA’s Academic Excellence Indicator System (AEIS) identified the district as having an academically acceptable rating. The third grade class accounted for 6.8% of the district’s student enrollment and had an average class size of fourteen students per teacher. State assessment scores for the third grade class indicated 77% of the students passed the state reading test, with 67.4% of the class’s economically disadvantaged
student population meeting the state’s passing standard in reading. The report showed 72.6% of the third grade passed the math test, and 63.6% of the economically disadvantaged population passed (Texas Education Agency, 2007-2012).

As Cohort I participants of the state’s TIP study, these third grade students were issued an Apple MacBook during their sixth grade year, which provided access to technology 24 hours a day seven days a week. Their state assessment scores were one of many components followed through the corresponding eTxTiP study. ETxTiP served as a four-year evaluation tool for the TIP program and followed this sixth-grade class along with 21 other high-need middle schools to chart changes and progress as a result of the technology immersion (Shapley et al., 2006)

Variables Examined

The dependent variable within this study was the individual reading and math state assessment scores for the same group of students within a selected district over an eight-year period. Student scores were converted to z-score standard deviation scores. This format is used widely in population-based assessments in the reporting of growth data. A z-score scale is linear, with fixed intervals allowing a group of z-scores to be used in summary statistics, including the reporting of mean and standard deviation (World Health Organization, 2013).

The independent variable was the implementation of the state funded TIP program made possible through the distribution of one-to-one mobile computing devices. For the purpose of this study, the three-year time span prior to implementation of the intervention was coded as 1. The initial time-point for the study was in 2002, the student group’s third grade school year. This was also the first year of the student group’s participation in the state assessment process. Student assessment scores from the initial three-year period established a baseline for the
analysis of student growth. Implementation of the intervention occurred during the fourth year, which was the student group’s sixth grade school year. It was this sixth grade group of students who became members of TIP’s Cohort 1 and followed through the state’s eTxTiP evaluative study. Implementation of the one-to-one mobile computing devices as an intervention occurred at the four-year mark and was coded as 2. Student assessment results continued to be followed past TIP’s implementation as sustainment of the one-to-one mobile computing initiative continued through local funding.

Procedure and Data Analysis

This study used piecewise growth modeling as a framework for analyzing the effects of one-to-one mobile computing devices over time. The immersion of technology through TIP served as the intervention within the study. The structural equation model analysis used within the piecewise growth model employed longitudinal data to estimate the mean rate of student growth at six time-points over three specific periods, including the pre-intervention period, the implementation of the intervention period, and the post-intervention period. The information provided through the pre-intervention period served to provide a baseline for determining student growth. The variations in growth rates among the group’s students and the correlates during each time period were identified. Of specific interest was student performance after the implementation of the intervention, including rate of student academic progress, and factors evident in promoting sustained growth during the post-intervention period (Seltzer & Svartberg, 1998).

The state assessment data required for this study was provided by the selected school district through regular state reporting measures. From this data, descriptive statistics were
formulated including mean and standard deviation for continuous variables and frequencies and percentages for categorical variables. Student academic achievement was measured using reading and math assessment data from the annual administration of the state assessment. In completing the study, two state assessments were used: Texas Assessment of Academic Skills (TAAS) and Texas Assessment of Knowledge and Skills (TAKS). Yearly assessment data over an eight-year period, beginning with the 2001-2002 school year, was gathered electronically. Scores from the TAAS and TAKS measures were converted to z-scores and reported in standard deviation units (SD).

Participants’ state assessment scores administrated annually over a period of eight years were used to complete a piecewise growth model analysis through the use of Mplus statistical software (Muthén & Muthén, 1998). The multivariate approach and structural equation modeling analysis provided through Mplus was beneficial in the consideration of data for inferential purposes (Byrne, 2012; Johnson, 2001). Missing data due to absences was addressed through the Mplus software. In addition, Mplus utilized maximum likelihood estimation under MCAR (missing completely at random) or MAR (missing at random) in contrast to obtaining a solution through list-wise deletion (Muthén & Muthén, 1998).

The output created through the analysis provided an estimate of the mean initial state assessment scores and rates of change produced over time through the immersion of technology. The piecewise growth model allowed for an interpretation of statistical significance in the rates of change and the inference of contributing factors including the covariates of participant demographics. Changes in academic performance as a result of long-time use of one-to-one mobile computing devices were identified over time with the rate of change, or slope, estimated at six time-points over three periods: pre-intervention, implementation of intervention, and post-
intervention. Time-points 1 and 2 were positioned in the pre-intervention period prior to implementation of the one-to-one mobile computing program. Time-point 3 was positioned at implementation of the intervention as a result of participation in Cohort 1 of TIP. Time-points 4, 5, and 6 were positioned during the post-intervention period, which completed the TIP Cohort 1 study and the school district’s sustainment of the one-to-one initiative.

Summary

Schools across the country continue to experience financial constraints and increased pressure to meet state and federal accountability requirements; therefore, the need for sound evidence of technology immersion and the use of one-to-one mobile computing devices as effective and efficient technological learning tools has heightened. The review of related literature showed that the push toward college and career readiness and the demands of 21st Century Skills require increased digital literacy. To better understand the academic influence digital learning plays on student learning, the study examined one-to-one mobile computing device initiatives across the country, with an emphasis on the Technology Immersion Pilot (TIP). Key features of the initiative were addressed, including the initiative’s purpose, its four-year evaluation, and the components that create the initiative’s framework. The review found that important steps to full immersion were instructional support and both initial and ongoing professional development. Unique to TIP was the grant’s selection of high need middle schools, many in small, remote, or rural locations. As a result, the review provided the groundwork necessary for a better understanding of the rural school and the Title I, economically disadvantaged, student population.
The purpose of this study was to examine the long-term academic impact of a one-to-one mobile computing technology initiative on a Title I rural school district and its students as measured through state reading and mathematics assessment scores as a result of the district’s initial participation in TIP and its continuation of the one-to-one mobile technology initiative. This study was unique in that the rapid growth and adoption of mobile devices within the school environment has not allowed for a longitudinal perspective to take place. Through the use of a piecewise growth model, state assessment data was collected from TIP’s first student cohort over an eight-year period beginning with the students’ third grade year, allowing for pre-intervention, implementation of the intervention, and post-intervention data to be included. Of interest were the changes over time based on the Texas Assessment of Knowledge and Skills (TAKS) scores among the student group over the eight-year period.

This study is significant because the current trends toward online learning platforms and bring your own device (BYOD) as a means to provide ubiquitous learning, greater student engagement, and increased academic achievement manifest in the one-to-one mobile computing initiative. The historical data generated from students’ state assessment scores in correlation with the implementation of TIP through the use of one-to-one mobile computing devices makes this longitudinal study of value in today’s educational setting.
CHAPTER 4

PRESENTATION OF FINDINGS

Introduction

The purpose of this study was to examine the long-term academic impact of a one-to-one mobile computing technology initiative on a selected Title I rural school district and its students as measured through state reading and mathematics assessment scores as a result of the district’s initial participation in the Texas Technology Immersion Pilot (TIP) and its continuation of the one-to-one mobile technology initiative. Within the ten-year period of testing, eight years of state assessment data were made available by the school district through state reporting measures. The data began in 2002 with the student group’s third grade reading and math Texas Assessment of Academic Skills (TAAS) scores. This was the students’ first experience with the state assessment process, and the state’s last administration of TAAS tests. The second set of data represented the students’ 2003 fourth grade math and reading results from their 2003 Texas Assessment of Knowledge and Skills (TAKS) tests. This was the group’s second year of participation in the annual state assessment process, and the state’s first administration of TAKS tests. No assessment data was available for 2004. The third set of data was compiled from the students’ 2005 sixth grade TAKS administration. It was during this school year that the school district was chosen to participate in the Texas Technology Immersion Pilot (TIP) and the sixth grade class, comprised of approximately 70 students, became members of the pilot’s first cohort. No assessment data was available for 2006. The remaining data was taken from TAKS tests administered from 2007 to 2009, students’ eighth grade through tenth grade school years. The 2010 test data showed no students within the group tested in reading or math despite 2009 assessment results indicating retests were required. As a result of the small sample size, the 2010
and 2011 TAKS data were not included. From the study’s start at the student group’s third grade year to the study’s finish at their tenth grade year, 47 members of the class were consistent.

The student scores provided through the state assessment data were converted to z-scores and through the use of a piecewise growth model used to determine individual student academic growth over time. The initial two years of assessment data formulated the baseline of the study. The implementation of technology immersion through one-to-one mobile computing served as the intervention. The data gathered through this process was used to address the following two research questions:

1. Does the implementation of technology immersion through one-to-one mobile computing devices impact the reading performance of students in a selected rural Title I public school district over time?
2. Does the implementation of technology immersion through one-to-one mobile computing devices impact the math performance of students in a selected rural Title I public school district over time?

In order to effectively answer these two research questions, a piecewise growth model was used to analyze student assessment scores at six time-points using Mplus statistical software (Muthén & Muthén, 1998). The confirmatory approach of this structural equation modeling analysis has proven beneficial in the analysis of longitudinal data over multiple phases for inferential purposes (Byrne, 2012; Johnson, 2001). Mplus addresses the presence of missing data through maximum likelihood estimation under MCAR (missing completely at random) or MAR (missing at random) instead of list-wise deletion (Muthén & Muthén, 1998) to obtain a solution. This feature was important in addressing the student enrollment variation over the study’s eight-year period. As a result of using this procedure, a model of best-fit was provided.
which included an estimate of the mean initial student assessment scores (s) and rates of change prior to implementation of the mobile one-to-one computing devices (s1) and after implementation of mobile one-to-one computing devices (s2). The piecewise growth model analysis afforded a focused analysis of the longitudinal relationship between the dependent and independent variables and an interpretation of statistical significance in the rates of change at the individual time-points as a result of the implementation of technology immersion through one-to-one mobile computing. In addition, the analysis allowed for the inference of contributing factors important in determining and better understanding the role and impact of technology immersion as an intervention on student academic success.

Descriptive Statistics

The information provided in the following tables and figures is presented as a result of the examination of the state required annual reading and math assessment scores for a specific student group within a selected rural Title I school. The study followed the student group’s individual members’ testing history beginning with the administration of their third grade state assessments. Of the 70 original members, 47 remained constant. A change in assessment occurred in 2003 between students’ third and fourth grade school years as the state moved from the TAAS test to the TAKS test. The use of a piecewise growth model examined the changes in the students’ performance over time as a result of the implementation of technology intervention through one-to-one mobile computing devices. The model identified the relationship between the dependent and independent variables. Descriptive statistics were identified including bivariate correlations, and multiple regressions and binary logistic regression models were calculated to analyze the data. The study indicated a steady decline in the number of testers. As
a result, the 2010 and 2011 student test scores and all demographic data were omitted from the piecewise growth model.

The sample size and continued decrease in number of participants over time is important to the statistical inference of this study. Sampling error is an expected part of the process, and the variations that arise through the use of a sample of the population make it is difficult to draw similar conclusions about the entire population. The larger the sample size the less opportunity for sampling error; likewise, the smaller the sample size, the greater the sampling error (Gay & Airasian, 2003). The small sample size of this study would result in greater sampling error; therefore, the findings cannot be generalized to a larger population.

The Impact of One-to-One Mobile Technology on Reading Performance

In order to complete the piecewise growth model analysis on reading performance, student state assessment scores were converted to z-scores. Students’ raw test scores, which were based on the number of item responses correct, were used for the conversion process. Table 7 utilizes this data in the descriptive statistics for all testers within the same third grade class. This school year was the students’ first year to participate in the required state testing. The table lists the number of testers within the class each year, the minimum score received, and the maximum score received based on the raw score format. The mean and the standard deviation values for each year’s student performance are also included. Data reports indicated 70 students started together as a third grade class, and while enrollment fluctuated up and down throughout the students’ testing years, the test information provided showed the class ended with a total enrollment of 52 during their eleventh grade school year. The minimum reading score of 0 was reported several years while the maximum student reading scores ranged annually from 36
The mean and standard deviation reflected the ongoing fluctuation in scores. Based on
the wide distribution of data among students’ scores within the group in relation to the mean, it is
easy to conclude that a large variance exists.

**TABLE 7**

*Mean Scores and Standard Deviations in Reading Performance (2002-2010) for All Testers*

*Using State Assessment Scores*

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 - 3rd Grade</td>
<td>70</td>
<td>0</td>
<td>36</td>
<td>25.90</td>
<td>8.37</td>
</tr>
<tr>
<td>2003 - 4th Grade</td>
<td>64</td>
<td>0</td>
<td>38</td>
<td>25.41</td>
<td>9.46</td>
</tr>
<tr>
<td>2005 - 6th Grade</td>
<td>63</td>
<td>14</td>
<td>42</td>
<td>30.87</td>
<td>6.49</td>
</tr>
<tr>
<td>2007 - 8th Grade</td>
<td>70</td>
<td>0</td>
<td>48</td>
<td>34.30</td>
<td>15.28</td>
</tr>
<tr>
<td>2008 - 9th Grade</td>
<td>73</td>
<td>0</td>
<td>37</td>
<td>29.03</td>
<td>6.88</td>
</tr>
<tr>
<td>2009 - 10th Grade</td>
<td>65</td>
<td>0</td>
<td>52</td>
<td>44.62</td>
<td>7.85</td>
</tr>
<tr>
<td>2010 - 11th Grade</td>
<td>52</td>
<td>30</td>
<td>52</td>
<td>45.19</td>
<td>5.52</td>
</tr>
</tbody>
</table>

Table 8 pulls from the broad information of student testers to identify the descriptive
statistics for the study’s participants. This group of students began the required state testing
process their third grade year and continued testing together through their high school years. The
table lists the number of testers within the class each year, the minimum score received, and the
maximum score received based on the raw score format. The mean and the standard deviation
values for each year’s student performance are also included. Data reports indicated 70 students
started together as a third grade class; however, a steady decline of the original membership
ensued each year. As a result, only 47 students remained during the students’ tenth grade school year. The continued drop of original testers during the eleventh grade school year resulted in the sample being dropped from the study’s model. The minimum reading score of 0 was reported several years while the maximum student reading scores ranged from 36 to 52. The mean and standard deviation reflected the fluctuation in scores over time. A large variance is evident due to the wide distribution of data among students’ scores within the group in relation to the mean.

**TABLE 8**

*Mean Scores and Standard Deviations in Reading Performance (2002-2009) for Study Participants Using State Assessment Scores*

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 - 3rd Grade</td>
<td>70</td>
<td>0</td>
<td>36</td>
<td>25.53</td>
<td>8.87</td>
</tr>
<tr>
<td>2003 - 4th Grade</td>
<td>64</td>
<td>0</td>
<td>38</td>
<td>25.19</td>
<td>9.61</td>
</tr>
<tr>
<td>2005 - 6th Grade</td>
<td>58</td>
<td>14</td>
<td>42</td>
<td>30.90</td>
<td>6.63</td>
</tr>
<tr>
<td>2007 - 8th Grade</td>
<td>51</td>
<td>0</td>
<td>48</td>
<td>38.85</td>
<td>10.1</td>
</tr>
<tr>
<td>2008 - 9th Grade</td>
<td>54</td>
<td>14</td>
<td>37</td>
<td>30.39</td>
<td>4.21</td>
</tr>
<tr>
<td>2009 - 10th Grade</td>
<td>47</td>
<td>25</td>
<td>52</td>
<td>46.24</td>
<td>5.08</td>
</tr>
</tbody>
</table>

Table 9 displays the descriptive statistics for the study’s participants using the z-score format. The conversion of raw scores to z-scores allows for a more accurate comparison of test scores. The table lists the number within the sample per year, the minimum and maximum z-scores, and the mean and standard deviation values for each year’s student performance. With a
mean of 0.0 and a standard deviation of 1.0, the resulting information shows no significant variation in range in either mean or standard deviation.

TABLE 9

Z-Score Means and Standard Deviations In Reading Performance (2002-2009) for Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>z-Score - Reading 2002</td>
<td>70</td>
<td>-3.06144</td>
<td>1.34304</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score - Reading 2003</td>
<td>64</td>
<td>-2.29104</td>
<td>1.70359</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score - Reading 2005</td>
<td>58</td>
<td>-3.71933</td>
<td>1.14812</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score – Reading 2007</td>
<td>51</td>
<td>-3.72904</td>
<td>1.73070</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score – Reading 2008</td>
<td>54</td>
<td>-3.42651</td>
<td>.95147</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score – Reading 2009</td>
<td>47</td>
<td>-2.76187</td>
<td>1.19310</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
</tbody>
</table>

To better identify the changes in the cohort’s state assessment scores in reading over time, a piecewise growth model analysis of the scores was used to study the data in two pieces: student state assessment scores prior to the implementation of the mobile one-to-one computing devices (Time-points 1 and 2) and student state assessment scores after the implementation of the mobile one-to-one computing devices (Time-points 4, 5, and 6). The implementation of the intervention occurred at Time-point 3. The fit indices were within reason with a Confirmatory Fit Index (CFI) at .962 and the Root Mean Square Error of Approximation (RMSEA) at 0.074.

A rate of change (slope) was first established for Time-points 1 and 2, which led up to the implementation of the devices, s1, and a second slope for Time-points 3, 4, 5, and 6 upon implementation of the devices and sustainment of the technology initiative, s2. The parameter
estimate, standard deviation, t-test, and 2-tailed p-value results for the intercept (i), and slopes for pre-implementation, s1, and post-implementation, s2, are reported in Table 10.

**TABLE 10**

*Slope and Intercept Results from Piecewise Growth Model Analysis of Reading Performance*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Deviation</th>
<th>t-test</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>0.002</td>
<td>0.119</td>
<td>0.016</td>
<td>0.987</td>
</tr>
<tr>
<td>s1</td>
<td>-0.069</td>
<td>0.056</td>
<td>-1.244</td>
<td>0.214</td>
</tr>
<tr>
<td>s2</td>
<td>0.035</td>
<td>0.040</td>
<td>0.866</td>
<td>0.387</td>
</tr>
</tbody>
</table>

Analysis of the data, as shown in Figures 1 and 2, indicated that there was not a statistically significant difference in student state assessment scores over time as a result of implementation and sustainment of the technology intervention, and therefore showed only nominal gain.

*Figure 1.* A model of the study participants’ group state assessment scores in reading. The graph illustrates the results of the piecewise growth model through estimated means over six time-
points during an eight-year period. Time-point 0 serves as the initial time-point for the growth model since it establishes the baseline for students’ state testing. Implementation of one-to-one mobile computing as an intervention occurred at Time-point 2. The change in academic performance during this time period was not statistically significant showing only nominal gain.

Figure 2. A model of the study participants’ individual state assessment scores in reading. The graph shows the estimated trajectory per student using the piecewise growth model through estimated means over six time-points. Time-point 0 serves as the initial time-point for the growth model since it establishes the baseline for students’ state testing. Implementation of one-to-one mobile computing as an intervention occurred at Time-point 2. The change in academic performance as a result of the intervention was not statistically significant showing only nominal gain.

The Impact of One-to-One Mobile Technology on Math Performance

In order to address the research question for math performance, the process for the piecewise growth model analysis was duplicated. Table 11 utilizes this data in the descriptive statistics for all testers within the same third grade class, which was the students’ first year to participate in the required state testing. The table lists the number of testers within the class each year, the minimum score received, and the maximum score received based on the raw score format. The mean and the standard deviation values for each year’s student performance are also included. Data reports indicated 70 students tested together as a third grade class, and despite a
slight increase in enrollment during the group’s ninth grade year, the class had only 52 testers in
the eleventh grade. The minimum reading score of 0 was reported six of the seven years, while
the maximum student reading scores ranged from 40 to 59. The mean and standard deviation
reflected the ongoing fluctuation in scores. Based on the wide distribution of data among
students’ scores within the group in relation to the mean, it is easy to conclude that a large
variance exists.

TABLE 11

*Mean Scores and Standard Deviations in Math Performance (2002-2010) for All Testers Using
State Assessment Scores*

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 - 3rd Grade</td>
<td>70</td>
<td>0</td>
<td>42</td>
<td>27.86</td>
<td>10.08</td>
</tr>
<tr>
<td>2003 - 4th Grade</td>
<td>64</td>
<td>0</td>
<td>40</td>
<td>27.88</td>
<td>8.56</td>
</tr>
<tr>
<td>2005 - 6th Grade</td>
<td>63</td>
<td>11</td>
<td>45</td>
<td>30.81</td>
<td>8.14</td>
</tr>
<tr>
<td>2007 - 8th Grade</td>
<td>70</td>
<td>0</td>
<td>49</td>
<td>29.27</td>
<td>14.44</td>
</tr>
<tr>
<td>2008 - 9th Grade</td>
<td>73</td>
<td>0</td>
<td>49</td>
<td>33.41</td>
<td>10.08</td>
</tr>
<tr>
<td>2009 - 10th Grade</td>
<td>65</td>
<td>0</td>
<td>54</td>
<td>37.42</td>
<td>12.15</td>
</tr>
<tr>
<td>2010 - 11th Grade</td>
<td>52</td>
<td>0</td>
<td>59</td>
<td>44.40</td>
<td>9.98</td>
</tr>
</tbody>
</table>

The descriptive statistics listed in Table 12 moves from all testers to focus on the math
performance of the study’s participants. This group of students began the required state testing
process their third grade year and continued testing together through their high school years. The
table lists the number of testers within the class each year, the minimum score received, and the
maximum score received based on the raw score format. The mean and the standard deviation values for each year’s student performance are also included. Data reports indicated 70 students started together as a third grade class. With the exception of the 2008 school year, a decline in the group of testers was observed each year. As a result, only 47 students remained during the students’ tenth grade school year. The continued drop of original testers during the eleventh grade school year resulted in the sample being dropped from the study’s model. The minimum math score of 0 was reported several years while the maximum student math scores ranged from 40 to 54. The mean and standard deviation reflected the fluctuation in scores over time. A large variance is evident due to the wide distribution of data among students’ scores within the group in relation to the mean.

TABLE 12

Mean Scores and Standard Deviations in Math Performance (2002-2009) for Study Participants

Using State Assessment Scores

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 - 3rd Grade</td>
<td>70</td>
<td>0</td>
<td>42</td>
<td>10.08</td>
<td>10.08</td>
</tr>
<tr>
<td>2003 - 4th Grade</td>
<td>64</td>
<td>0</td>
<td>40</td>
<td>8.87</td>
<td>8.87</td>
</tr>
<tr>
<td>2005 - 6th Grade</td>
<td>58</td>
<td>12</td>
<td>45</td>
<td>7.26</td>
<td>7.26</td>
</tr>
<tr>
<td>2007 - 8th Grade</td>
<td>51</td>
<td>0</td>
<td>45</td>
<td>10.44</td>
<td>10.44</td>
</tr>
<tr>
<td>2008 - 9th Grade</td>
<td>54</td>
<td>0</td>
<td>49</td>
<td>9.31</td>
<td>9.31</td>
</tr>
<tr>
<td>2009 - 10th Grade</td>
<td>47</td>
<td>27</td>
<td>54</td>
<td>7.77</td>
<td>7.77</td>
</tr>
</tbody>
</table>
Table 13 focuses on the participants’ z-scores in relation to the mean and standard deviation values for each year’s state assessment performance. The use of z-scores allows for a more accurate comparison of test scores. The table lists the number of participants within the sample, and the minimum and maximum z-scores in math for each year. The analysis identifies a mean of 0.0 and a standard deviation of 1.0 with no significant variation in range in either mean or standard deviation.

TABLE 13

Z-Score Means and Standard Deviations In Math Performance (2002-2009) for Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>z-Score - Math 2002</td>
<td>70</td>
<td>-2.86179</td>
<td>1.74717</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score - Math 2003</td>
<td>64</td>
<td>-2.19841</td>
<td>2.34024</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score - Math 2005</td>
<td>58</td>
<td>-2.62514</td>
<td>1.62675</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score - Math 2007</td>
<td>51</td>
<td>-3.35494</td>
<td>1.10617</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score – Math 2008</td>
<td>54</td>
<td>-3.47469</td>
<td>1.29418</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
<tr>
<td>z-Score – Math 2009</td>
<td>47</td>
<td>-3.91282</td>
<td>1.25298</td>
<td>.0000000</td>
<td>1.00000000</td>
</tr>
</tbody>
</table>

To examine the changes in math performance over time, the piecewise growth model was used to analyze the state assessment scores in math for the study’s participants in the selected school. Two pieces were examined: student state assessment scores prior to the implementation of the mobile one-to-one computing devices (Time-points 1 and 2) and student state assessment scores after the implementation of the mobile one-to-one computing devices (Time-points 4, 5,
and 6). Technology immersion through one-to-one mobile computing served as the intervention at Time-point 3. The fit indices were within reason with a Confirmatory Fit Index (CFI) at .968 and the Root Mean Square Error of Approximation (RMSEA) at 0.092.

A rate of change (slope) was established for Time-points 1 and 2, s1, indicating student assessment performance prior to implementation of the intervention. A second slope for Time-points 3, 4, 5, and 6, s2, was constructed noting implementation of the devices as an intervention and sustainment of the technology initiative, s2. The parameter estimate, standard deviation, t-test, and 2-tailed p-value results for the intercept (i), and slopes for pre-implementation, s1, and post-implementation, s2, are reported in Table 14.

**TABLE 14**

*Slope and Intercept Results from Piecewise Growth Model Analysis of Math Performance*

<table>
<thead>
<tr>
<th></th>
<th>Parameter Estimate</th>
<th>Standard Deviation</th>
<th>t-test</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>0.001</td>
<td>0.117</td>
<td>0.004</td>
<td>0.997</td>
</tr>
<tr>
<td>s1</td>
<td>-0.062</td>
<td>0.046</td>
<td>-1.341</td>
<td>0.180</td>
</tr>
<tr>
<td>s2</td>
<td>0.001</td>
<td>0.038</td>
<td>0.023</td>
<td>0.982</td>
</tr>
</tbody>
</table>

Analysis of the data, as shown in Figures 3 and 4, indicated that there was not a statistically significant difference in student state assessment scores over time as a result of implementation and sustainment of the technology intervention and showed a nominal decline.
Figure 3. A model of the study participants’ group state assessment scores in math. The graph illustrates the results of the piecewise growth model through estimated means over six time-points during an eight-year period. Time-point 0 serves as the initial time-point for the growth model since it establishes the baseline for students’ state testing. Implementation of one-to-one mobile computing as an intervention occurred at Time-point 2. The change in academic performance during this time period showed no statistical significance with a nominal decline.
Figure 4. A model of the study participants’ individual state assessment scores in math. The graph shows the estimated trajectory per student using the piecewise growth model through estimated means over six time-points during an eight-year period. Time-point 0 serves as the initial time-point for the growth model since it establishes the baseline for students’ state testing. Implementation of one-to-one mobile computing as an intervention occurred at Time-point 2. The change in academic performance as a result of the intervention showed no statistical significance with a nominal decline.

The purpose of this chapter was to provide results from statistical analysis examining the impact of a one-to-one mobile computing initiative on student performance in reading and math. In doing so, state assessment scores in the two content areas were examined using a piecewise growth model. This analysis model is a valued tool to identify growth based on the implementation of one or more interventions over an extended period. Correlation, logistic regression and linear regression results were included showing the relationships of the one-to-one initiative as an intervention within this model. The results of the analysis indicate no significant increase in student academic performance based on implementation and sustainment of the devices.
CHAPTER 5
ANALYSIS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This purpose of this study was to determine the impact technology immersion plays on reading and math performance of students through the implementation of one-to-one mobile computing devices in a selected rural Title I public school. Through the use of an interrupted time series research design, a longitudinal perspective was incorporated into the study. This allowed for an in-depth look at student growth over time as a result of the implementation of one-to-one mobile computing devices. As part of the research, student demographic information was incorporated into the analysis to determine if the implementation of technology immersion as an intervention had any significant impact on student academic performance in the core content areas of reading and math.

The groundwork for this study was established through the Texas Technology Immersion Pilot (TIP) by selecting and following the academic progress of one of the pilot’s participating schools. TIP’s implementation of technology immersion was at the sixth grade level. The selected school district reported 70 sixth grade students in the grant’s first year cohort. In order to complete the eight-year testing window of this study, additional test results were also gathered beginning with the class’s third grade year, three years prior to participation in the pilot, and ending at the completion of the required administration of the high school reading and math state assessments. The selected school district is located in a rural area in Texas and is designated as a Title I school based on the large percentage of students qualifying for free and reduced meals through the National School Lunch Program. This district’s continued sustainment of technology immersion through mobile one-to-one computing devices after the completion of the
pilot made it a viable district for studying the longitudinal impact of technology through a piecewise growth model.

Within the study’s longitudinal focus, eight years of state assessment data were made available by the school district through state reporting measures. In examining the test results, six time points were selected. The frequency, percent, mean, and standard deviation were identified within each core-content area of analysis in order to distinguish academic growth over time. Through the comparison of variables, the mean, standard deviation, and Pearson product-moment correlation coefficient were established. Levels of significance were determined at the .05 level. An assumption of this study was that due to the implementation and continued sustainment of the one-to-one mobile technology initiative, student academic performance would show marked increases over time. However, the piecewise growth model, fit to the data collected through state reporting of math and reading assessment scores, suggested that technology immersion through one-to-one mobile computing did not contribute to increased academic performance in the two core-content areas.

The review of literature focused on the implementation of one-to-one mobile computing initiatives across the nation including the Texas Technology Immersion Pilot (TIP), considered important in groundbreaking one-to-one mobile initiatives. Because the basis of this study was grounded in the selected school district’s involvement in the TIP state grant project and continued sustainment of the intervention, extensive research of literature was conducted on TIP and its corresponding evaluation pilot, the Evaluation of the Texas Technology Immersion Pilot (eTxTip). Additional one-to-one initiatives across the country were explored with the research base showing varied results of the technology immersion especially in regards to continuation of the initiatives. Many of the schools initially implemented one-to-one computing based on one-
time special funding opportunities, yet goals of increased academic improvement failed to come to fruition. Additional issues addressed within the review of literature were rural schools and the economically disadvantaged student population. Geographical proximity and economic issues, which affect a large number of schools and students within the nation, are important factors in advancing the educational opportunities for all students and providing ubiquitous access to information regardless of location. The literature review also explored teacher professional development including the need for increased technology skills and support to offset the disruptions brought about by the implementation of new forms of mobile technology and the transformations required to create a digital learning environment. The review indicated that although disruptive innovations prove to be a positive force, administrator foresight and educator training are critical to successful technology integration. The need for effectiveness and efficiency of the intervention, including the funding and resources required to sustain its use, proved pivotal in individual school and district decisions on continuation of one-to-one mobile computing initiatives.

An important feature to consider regarding this study is that currently limited research exists which focuses on student academic growth as a result of one-to-one technology immersion specifically when used over an extended period of time. A primary reason is the fact that technology immersion is still relatively new in the educational field, hindering the ability for long-term, in-depth analysis. Technology plays an important role in individualizing instruction and allowing students to construct their own knowledge; therefore, research is critical as the integration of technology in the classroom continues to increase through use and ease of access to both mobile computing devices and Internet connectivity.
Discussion of Findings

The ubiquitous aspect of technology immersion draws on the ability of mobile technology to transform teaching and learning through anytime-anywhere access to knowledge. The establishment of technology immersion though the TIP grant and the sustainment of that technology through continued access to one-to-one mobile technology set an expectation for increased learning outcomes. The eTxTiP evaluation, which coincided with TIP to identify the long-term effects of technology immersion on middle school students’ academic achievement, showed varied results of technology immersion on academic achievement among the three cohorts within its four-year study. The school selected for this study was a member of Cohort 1.

The eTxTiP findings for Cohort 1 reported a statistically significant and positive sustaining effect in reading as the group moved through three years of technology immersion (Shapley et al., 2009). The selected school began its testing career in 2002 with 70 participants; however, only 47 of the original testers were still participating in the assessment process as the class moved to the high school level. This information is reported in Table 7. The use of the piecewise growth model to examine z-scores over time allowed for a detailed view of academic performance in reading prior to implementation of the one-to-one mobile computing devices and after implementation. Through the use of this data, a rate of change was estimated for the first two time points leading up to Time-point 3 when the mobile devices were implemented. A second slope was determined from implementation of the devices through sustainment, which coincided with the administrations of the high school level state assessments. The results of this study indicated that the selected school showed no statistically significant gain in academic performance in reading among the study participants. The results for the intercept, I, and slopes for pre-implementation, s1, and implementation and sustainment, s2, are reported in Figure 1.
Although there was no statistically significant change in the group’s reading performance, the piecewise growth model utilized estimated means over 6 time-points to create an estimated trajectory per student. Through this process, a nominal gain was observed. The results are reported in Figure 2.

In regard to math performance, eTXTiP reported a positive but statistically non-significant effect of technology immersion on math performance for Cohort 1 (Shapley et al., 2009). Again, the selected school began its testing career in 2002 with 70 participants and ended with only 47 of the original testers participating in the assessment process at the high school level. This information is reported in Table 9. The use of the piecewise growth model to examine z-scores over time allowed for a detailed view of academic performance in math prior to implementation of the one-to-one mobile computing devices and after implementation. Using this information, a rate of change was estimated for the first two time points leading up to Time-point 3 when the mobile devices were implemented. A second slope was determined from implementation of the devices through sustainment, which coincided with the administrations of the high school level state assessments. The results of this study showed no significant statistical gain in academic performance in math among the study participants. The results for the intercept, I, and slopes for pre-implementation, s1, and implementation and sustainment, s2, are reported in Figure 3.

Although there was no statistically significant change in the group’s math performance, the piecewise growth model utilized estimated means over 6 time-points to create an estimated trajectory per student. Through this process, a nominal decline was observed. The results are reported in Figure 4.
Two possibilities exist for the lack of academic growth in both reading and math. In addressing the results, it is important to refer back to two items discussed within the literature review: disruptive technologies and professional development. The eTxCiP study understood the importance of these two areas and utilized both within the framework of the TIP evaluation. Technology immersion through one-to-one mobile computing presents a platform for disruptive innovation to manifest. It also requires an understanding that teacher training and pedagogical support are required in order to meet the instructional demands brought about by the implementation of devices and ongoing evolution of mobile learning.

The lack of statistical significance in both reading and math, as noted in Figures 1 and 3, as a result of implementation of one-to-one mobile computing supports the plausibility of these two factors. The slope following Time-point 3 at the intervention’s implementation in Figure 1 indicates a nominal gain in reading; however, when examining the individual scores within the group, as noted in Figure 2, the lack of growth and decline for many students is much more visible. Figure 3 shows a slight decline in math following the implementation of the devices at Time-point 3. A similar scenario exists for the individual math scores in Figure 4, as the lack of growth and decline for many is observable following implementation at Time-point 3.

Recommendations for Further Research

Although results from the study did not provide the statistical significance needed to support technology immersion through one-to-one mobile computing as a proven intervention toward increased academic performance, the continued advancement of technology as a learning tool requires further observation, exploration, and understanding. The investment required for
successful implementation of a one-to-one mobile computing program is costly for school districts. Purchasing devices and providing a solid infrastructure to support emerging technologies require a solid understanding of effective and efficient fund use. However, the investment reaches much deeper than financial buying power entailing additional emphasis on leadership, professional development, sufficient resources, and communication of expected outcomes through technology use (Burke et al., 2012). Continued unbiased research will provide the needed guidance for future one-to-one mobile computing initiatives. The increasing number of school districts participating in one-to-one mobile computing initiatives provides an added layer of confidence to research possibilities as sample sizes increase at both the elementary and secondary school levels and in both rural and urban areas. Based on the findings of this study, the following recommendations are offered:

1. A related longitudinal study should be conducted to increase the sample size of both the total population and specific sub-populations. The identification and inclusion of other TIP participating schools that continued the one-to-one initiative after the grant period would broaden the view of the intervention’s impact on academic growth while also honing in on the initiative’s effect on student performance within the demographic sub-populations.

2. A related longitudinal study should be conducted drawing on the increased number of schools participating in one-to-one mobile computing programs. Various lenses could be used including elementary level, secondary level, small school, large school, rural, urban, district, and charter. The varied range in current school participation would provide research-based, targeted information vital in stakeholder decision-making.
3. A related study should be initiated to examine the professional development offerings, mentoring, and collaborative support of technology-immersed one-to-one schools. This study would aid in determining if teachers’ individual levels of technology proficiency and ongoing participation in technology-related trainings with support of collaborative efforts such as mentoring and professional learning communities (PLC) impact the level of technology immersion within the school and individual classrooms, the transformation of learning within those environments, and ultimately student outcomes.

4. A related study should be conducted with building and campus leadership to determine their perceptions and attitudes toward technology immersion and the implementation of one-to-one mobile technology, their communication of expectations to teachers, and their commitment toward putting resources and safeguards in place to support implementation. These variables could then be used to examine the resulting level of technology immersion within the respective school environments and the impact on student academic achievement.

5. A related study should be conducted with teachers regarding their perceptions of their administrators’ expectations for the implementation of technology immersion through one-to-one mobile computing including school leadership’s stated levels of acceptability and support. In conjunction, teacher technology proficiency and confidence level in meeting expected outcomes should be explored. The information could then be used to examine the level of technology immersion within the school environment and the digital classroom’s impact on student academic performance.
6. A related study should be conducted with students to determine their attitudes and perceptions as digital learners toward technology immersion through one-to-one mobile computing including meeting individual learning needs, constructing personalized knowledge, and increasing student engagement. The information gathered could then be used to better understand the impact of mobile computing on student learning and academic achievement.

7. A related study should be conducted with parents and community stakeholders to explore their attitudes toward technology immersion through one-to-one mobile computing, their expectations of student learning as a result of emerging technologies, and the resulting impact of program implementation on student academic achievement and school performance. The information gathered through research would provide data required to form a strong home-school-community partnership and a better understanding of the transparency required in communicating and carrying out educational visions.

Conclusions

As educators explore the roles that emerging technologies play, technology immersion through one-to-one mobile computing finds its place at the forefront of digital learning. In this context, one-to-one mobile computing is viewed as a tool to support student learning through access to relevant and timely information, engage students in the learning process through meaningful learning experiences, and transform the classroom environment allowing students to both construct and customize their own learning.
This interrupted time series study was based on the Texas Technology Immersion Pilot (TiP), a state-funded study implemented in 2005 among 22 middle schools with a focus on the effects of technology immersion through the implementation of one-to-one mobile computing. In order to better understand student academic growth over time through the use of mobile computing devices, a school was selected from the TiP participants for further analysis. The selected middle school’s size, rural location, and predominantly economically disadvantaged student population were demographic characteristics reflective of a large number of schools across the state. Unique to this school was its sustainment of the one-to-one initiative after the TiP study period due to district support and continued funding. This study used district-provided available state assessment scores and a piecewise growth model to examine the impact over time of technology immersion through the implementation of one-to-one mobile computing devices on reading and math performance.

In addressing this study, the following conclusions are presented with reference to the analysis of data and the compilation of information collected through the related literature review:

1. The study indicated the change in academic performance in reading over time as a result of the implementation of technology immersion through one-to-one mobile computing was not statistically significant and showed only a nominal gain. The analysis of the estimated trajectory per student was also not statistically significant with a nominal gain.

2. The study indicated the change in academic performance in math over time as a result of the implementation of technology immersion through one-to-one mobile computing was not statistically significant and showed a nominal decline. The analysis of the estimated trajectory per student was also not statistically significant with a nominal decline.
3. The study indicated a drop in academic performance in both reading and math at implementation of the one-to-one mobile computing initiative. Based on the literature review, technology immersion through emerging technologies such as one-to-one mobile computing presents a platform for disruptive innovation. Educators must move from the mindset of the traditional learning environment to one of innovation, as the “one-size-fits-all” approach to education no longer meets the needs of today’s learners. The transformation of teaching and learning through the implementation of technology requires an understanding that with each new idea and innovation, disruption occurs at both the teaching and learning levels.

4. The study revealed only nominal change following implementation of the one-to-one mobile computing initiative. The ubiquity of anytime-anywhere learning made possible through mobile computing devices hinges on access to content in multiple formats and educator knowledge of the varied online learning platforms. Professional development, both initially and ongoing, is fundamental to meeting the pedagogical demands of a technology-immersed classroom and the seamless integration of one-to-one mobile computing initiatives. Implementation of mobile learning and the evolution of digital content require the educator to have an understanding of theory and practice, and an awareness of the changes required in context, pedagogy, and curriculum for the customization of student learning and the producing of rich, meaningful classroom experiences (Crompton & van’t Hooft, 2012; Novak, 2012).

5. The study explained that despite the rapid adoption and widespread use of mobile technologies, the implementation and sustainment of one-to-one mobile computing initiatives lack the research necessary to fully determine the impact of technology
immersion on today’s learner. Recommendations for additional research included the exploration of perceptions and expectations of teachers, school leadership, parents, and community stakeholders in relation to implementation and sustainment of one-to-one computing programs.
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