TECHNOLOGY INTEGRATION IN MIDDLE SCHOOL MATHEMATICS AND READING ACHIEVEMENT: IMPLICATIONS FOR SCHOOL LEADERS

A Doctoral Thesis Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Education
in Professional Leadership

by

Rhonda Ruth Wade

May 2013

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Dedication

For Victor Wade, whose selfless love and sacrifice made this dream a reality.

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My sincerest gratitude is given to my committee chair, Dr. Sara McNeil, who guided me through this process. My success is attributed to her wisdom in each decision to be made, from topic selection to committee members. Her gentle encouragements to exceed deadlines were invaluable.

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An Abstract
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Abstract

Educational leaders must support teachers in facilitating successful technology integration to impact teaching and learning. To provide this support, leaders need to understand what comprises effective integration of technology to have an impact on student achievement. This study examined the relationship between the degree to which school campuses had implemented technology into teaching and learning and the corresponding impact on student performance in reading and mathematics.

The Texas Assessment of Knowledge and Skills (TAKS) scores for all Texas middle schools for the school year 2010-11 were correlated with three components in the Teaching and Learning area of the Texas Campus Student Technology and Readiness (STaR) Chart. Probit regression analyses of the three target areas on the student scores showed that Patterns of Classroom Use and Content Area Connections were each significantly uniquely predictive of achievement results. Leaders should ensure that teachers are equipped to integrate technology in their content.

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CHAPTER 1
Introduction

The solutions to many of the world's problems will be discovered with the use of technology. In order to compete in the global marketplace, students must be equipped with 21st century skills. Technology can be utilized to create teaching and learning environments where students are more engaged and increase knowledge (Texas Education Agency, 2010). The issue is not whether technology will be utilized in education but the impact of technology on the learning of our students. The results from the Speak Up 2010 Survey (2011), collected and analyzed by the national education nonprofit group Project Tomorrow, indicate that students desire emerging technologies that include mobile and online learning as well as digital content. In addition, students visualize an engaging learning environment where content is contextually based and learning is personalized. In fact, school administrators recognize that the use of technology can provide an engaging environment (SpeakUp National Research Project, 2011). Schools must strategically evaluate emerging technologies to best serve the needs of students.

STATEMENT OF THE PROBLEM

While there are significant investments that school districts make in technology, there is little evidence to support the impact of technology integration in teaching on student performance as measured by high-stakes testing. While research exists on both sides of the technology issue, few research studies have been conducted which identify the level of technology integration with regards to frequency of use, teaching pedagogy, and content area connections.

According to Secretary of Education Arne Duncan, the current state of our education system is "economically unsustainable and morally unacceptable" (Duncan, 2010). Current data supports Duncan's statement. Approximately 25 percent of US students fail to graduate on time with a regular diploma (Stillwell, 2010). For Latino and African-American students, the number is almost 40 percent. The National Center for Education Statistics (NCES) suggests that of the students who do graduate from high school, one-third are unprepared for further education, thus forcing colleges and universities to devote time and resources to remedial work (2003). These statistics are aggravated by the fact that by 2016, 40 percent new jobs will require some advanced education (Dohm, 2007). Furthermore, education has failed forty-four percent of adults living in America who could benefit from English literacy instruction (NCES, 2009).

Gains in learner achievement have been slow or negligible. Between 2007 and 2009 there was no measurable change in the average grade 4 reading score on the National Assessment of Education Progress (NAEP) and only an increase of 1 point on the grade 8 reading score. For grade 12, the percentage of students scoring at below basic reading achievement went from 27% in 2005 to 26% in 2009. The results for mathematics gains were somewhat better. Grade 4 students gained approximately 12% on the NAEP with grade 8 students gaining about 8%. However, the percentage of grade 12 students scoring below basic mathematics achievement only dropped 3% from 39% in 2005 to 36% in 2009 (NCES, 2011).

America strives to develop inquisitive, creative, resourceful thinkers, informed citizens, effective problem–solvers, groundbreaking pioneers, and visionary leaders (US Department of Education, 2010). However, to accomplish these goals, students must be fully engaged in school. The level of engagement needed requires the use of technology environments and resources (US Department of Education, 2010).

To remain competitive in an ever-changing global economy, schools must be more strategic, aggressive, and effective in preparing students for success. (Partnership for 21st Century Skills, 2012). There is a growing gap between the needs of America's manufacturing industries and the Science, Technology, Education and Mathematics (STEM) skills that employees possess (The Council on Competitiveness, 2011). Manufacturing representatives believe that STEM education in the lower grade levels will result in long term interest in manufacturing, which could assist in America remaining competitive (The Council on Competitiveness, 2011). Nations that foster knowledge and innovation – including technological advances - have historically led the world in prosperity (Partnership for 21st Century Skills, 2012).

TECHNOLOGY LEADERSHIP

*The National Education Technology Plan (*NETP) acknowledged that the use of technology-based learning will be pivotal to improving student learning. In order to achieve dramatic student gains, learning must be powered by technology (US Department of Education, 2010). Without effective leadership, schools cannot reach the potential that technology provides. The challenge for educators is to use technology to make learning relevant to reflect students' daily lives. Bringing 21st century technology into learning can engage and motivate learners to achieve (US Department of Education, 2010).

Technology can also provide access to a wider set of learning resources than is available in the classroom. Engaging and effective learning experiences can be differentiated or personalized to the needs and experience of each learner. Opportunities for students to take ownership of their learning are inherent with the use of technology. Electronic learning portfolios can help students develop the self-awareness needed to set their own learning goals (US Department of Education, 2010) .

Education lags behind every other major industry in using technology effectively as a tool for productivity, learning, communications, and creativity (Edyburn, 2006). With districts under pressure to improve student achievement and modernize educational practices, superintendents must be at the vanguard of technology leadership to reach this new frontier (Consortium for School Networking, 2010). *The National Education Technology Plan*, released by the U.S. Department of Education in early 2010, recognized a need to "strengthen leadership" in order to move forward on the technological frontier. Research indicates that technology leadership matters for promoting teachers' uses of technology more so, in fact, than technology expenditures or infrastructure--and administrators must understand what is involved in this process of leading their schools' or districts' technology integration to be successful (Schrum, Galizio, & Ledesma, 2011). Administrators have been virtually left out of understanding the challenges to support the effective use of educational technology in instruction. Teachers must have the leadership of administrators to successfully use technology; the lack of administrative support is the most important variable affecting the implementation of technology integration (Schrum, Galizio, & Ledesma, 2011).

The International Society for Technology in Education (ISTE) has created National Education Technology Standards (NETS) for students, teachers, and administrators. These standards establish a framework of best practices in regards to technology in education. The specific NETS for Administrators addresses five key areas: (1) visionary leadership, (2) digital age learning culture, (3) excellence in professional practice, (4) systemic improvement, and (5) digital citizenship (International Society for Technology in Education, 2009). The visionary leadership standard charges administrators with creating a shared vision for technology integration. Administrators also should promote a culture where digital-age learning is modeled, promoted, and provided for learner-centered environments. Educators should be empowered to enhance student learning in an environment that promotes professional learning in regards to the study and use of digital age tools. Technology and information resources are critical tools to continuously improvement schools. Administrators should maintain an appropriate infrastructure for technology and lead the charge to maximize achievement through technology resources. Finally, with the evolving nature of our digital culture, leaders must establish policies that promote the safe, legal, and ethical use of digital technology.

The Washington, D.C.-based Consortium for School Networking (CoSN) released an updated version of *Empowering the 21st Century Superintendent*, a blueprint for seizing the technological initiative in areas ranging from better integrating technology into classroom instruction, to creating professional learning communities for teachers, to inventing more complex assessments of student work. CoSN's document makes the case that the effective use of educational technologies is crucial and provides steps for implementation (Schachter, 2010). The five major focuses of a district's leadership in regard to technology should include modeling the use of new technologies, ensuring that technology is integrated in teaching 21st century skills, boosting Web 2.0 applications in student learning, offering professional development in technologies and deploying online tools that provide learning communities, and providing balanced assessments of student work enhanced by technology tools (Consortium for School Networking, 2010).

Background Of The Problem

In January, 2002, President George Bush signed the No Child Left Behind Act (NCLB) as a reauthorization of the Elementary and Secondary Education Act. NCLB emphasizes improving student achievement through "the use of technology in elementary and secondary schools through integration initiatives, building access, accessibility, and parental involvement" (Learning Point Associates, 2007). Title II, Part D of NCLB, also known as *Enhancing Education through Technology*, outlines goals to improve student academic achievement through the use of technology, to ensure that students are technologically literate by the end of grade 8, and to establish effective technology-integrated instructional methods (Learning Point Associates, 2007).

Since NCLB, high stakes testing to measure student achievement has reached new levels. Although school accountability has been an ongoing movement, NCLB mandated state-by-state standardized testing and included rewards and sanctions for under-performing schools (Parkes, 2003). The driving force for integrating technology into K-12 education comes in preparing students for the workforce and increasing student knowledge and skills. (Lowther, Inan, & Strahl, 2005). The use of technology represents an underutilized intervention for enhancing the academic performance of students

(Edyburn, 2006). In fact, as of 2009, only twenty-eight percent of teachers reporting having access to interactive whiteboards and only forty-eight percent had access to digital projectors (Gray, Thomas, & Lewis, 2010).

Beginning in 1992, all schools in Texas were eligible to receive a technology allotment of approximately $30 per student in order to support the goals in the *Long Range Plan for Technology* (Texas Education Agency, 2011). Since 2002, the US Department of Education has budgeted over $4.4 billion for state educational technology grants. In 2009 alone, $269 million was budgeted for state educational technology grants with an additional $650 million allocated in the American Recovery and Reinvestment Act of 2009 (US Department of Education, 2010). Policy makers need to know if the investment in technology has produced positive results.

In the *Evaluation of the Enhancing Education through Technology Program Final Report* (2009), the U.S. Department of Education noted that improved academic achievement can potentially result from the integration of technology in two ways. First, technology integration can lead students to learn better and faster through test preparation activities, formative assessment, individualized instruction, and a more engaging curriculum. Second, students who are technology literate can learn the important skill of accessing and analyzing information.

Purpose

The purpose of this study was to examine the relationship between the degree to which a school campus has implemented technology into teaching and learning and the corresponding impact on student performance. The three focus areas of technology integration in teaching and learning examined included: (1) patterns of classroom use;

(2) frequency/design of instructional setting using digital content; and (3) content area connections. Specific questions identified included: (1) How does the degree of implementation in the three focus areas relate to student achievement in math? (2) How does the degree of implementation in the three focus areas relate to student achievement in reading? and (3) Is there a difference in the achievement of students in reading and math at campuses with target levels of integration in the three focus areas? These questions deal with whether the level of implementation has an impact on student achievement in Texas middle schools.

SIGNIFICANCE OF THE STUDY

This study provided data about whether a relationship exists between student achievement and the level of technology implemented by campuses and may provide research-based support for school leaders and law makers in making changes in curriculum and instruction. Since the sample size included the entire population of middle school campuses in Texas, it is reasonable to assume that the results could be generalized to a larger population.

RESEARCH QUESTIONS

1. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores?
2. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores?

3. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores?
4. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores?
5. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores?
6. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores?

DEFINITION OF TERMS

The following terms are defined as they are used for the purposes of this study.

Computer-aided instruction (CAI). This type of instruction provides software designed to help teach information and/or skills related to a topic (Roblyer & Doering, 2010).

Educational technology. Educational technology is an array of tools helpful in advancing student learning. It refers to machines, hardware, and software but can also include systems methods of organization and techniques (Schrum & Levin, 2009).

Integrated Learning Systems. Integrated learning systems (ILS) refer to software programs that provide tutorial instruction at different grade levels and keep records of student progress (Kulik & National Science Foundation, 2002).

Middle schools. Schools that consist of grades six, seven and eight students exclusively, including schools entitled Junior High School, Middle School or Intermediate School.

Technology integration. Technology integration is the merging of technology resources and technology-based practices into the daily operation of the classroom. It is the employment of hardware and software during classroom instruction.

Texas Assessment of Knowledge and Skills (TAKS). TAKS consists of subject-area tests administered to schools in grades three through eleven. In grades six through eight, subjects tested include Reading, Writing, Mathematics, Social Studies, and Science. However, only the Reading and Mathematics test are administered for all students in grades six through eight.

LIMITATIONS

The accuracy of the STaR Chart data is limited to the level of accuracy and standardization of answers from teachers. STaR Chart data is self-reported, and the levels of integration are a self-analysis by teachers. Persons completing the survey may not accurately assess the technology component in each area. Nonetheless, the STaR Chart is the only statewide assessment of technology integration in the state of Texas. The Texas Education Agency (TEA) requires campuses and districts to complete and submit the data in order to be eligible for technology grant programs.

This study was limited to middle school campuses in Texas serving students in grades six through eight. Another limitation was that this study was restricted to the achievement in two core subject areas: reading and mathematics. While technology integration obviously can affect other subject areas, reading and mathematics were chosen because they are the only subject areas tested in every sixth through eighth grade level.

A final limitation of this study is that a variety of other factors can affect student achievement and teachers' technology integration. Teacher competency in using technology would affect the level of technology integration. Student background knowledge, socio-economic status, attitudes toward technology, gender, and ethnicity may also affect the achievement of students.

SUMMARY

The US Department of Education (2010) recognizes that technology is necessary to fully engage students in school. Bringing 21st century technology into learning can engage and motivate learners to achieve (US Department of Education, 2010). The challenge is for leaders to guide educators in using technology to make learning relevant and effective for students.

Kulik (2003) asserts that it is not yet clear how much technology can contribute to the improvement of instruction. Some research has shown student achievement, engagement, and motivation increase when teachers integrate technology into instruction (Funkhouser, 2002; Lin C. , 2006). However, other research results have not produced a strong case for the impact of technology on teaching and learning (Fitzgerald, Koury, & Mitchem, 2008; Lin, Ching, Ke, & Dwyer, 2007; Roblyer & Doering, 2010). This study contributed to the field of study by focusing on the relationship of the level of technology integration to student achievement for reading and mathematics.

CHAPTER 2
Literature Review

OVERVIEW

Technology integration in education has been promoted and attacked. Advocates of technology in education point to gains in student achievement (Chandra & Lloyd, 2008; Hsieh, Cho, Liu, & Schallert, 2008). Detractors of technology use cite research that suggested money spent on technology is wasted (Cuban, 2001; Oppenheimer, 2003). Oppenheimer (2007) also adds that software companies often use faulty research reports in order to sell software. However, a prevalent theme is that technology can make positive increases in student achievement if technology is applied in an appropriate manner (Hartnell-Young, 2006). Technology is a tool that should be applied in such a way that students do not even notice its involvement (Warlick, 2007).

Kulik (2003) asserts that it is not yet clear how much technology can contribute to the improvement of instruction. Although many researchers have carried out controlled evaluations of technological effects during the last three decades, the evidence is too limited for sweeping conclusions about the effectiveness of instructional technology. Kulik also notes that recent evaluation studies (especially those done in the last decade or so) suggest that schools are more successful in the use of instructional technology than they were in the previous decade.

Johnson and Maddux (2007) outlined the four conditions under which technology integration could occur: (1) capacity – providing quality hardware software and connectivity; (2) accessibility – by both teachers and students; (3) implementation – appropriate teaching practices utilizing technology; and (4) support- by policymakers and administration. While capacity, accessibility and support are necessary, the goal of this study is to investigate the impact of appropriate implementation on student learning.

Constructivism and Technology Integration

Saunders (1992) defines constructivism as “the notion that learners respond to their sensory experiences by building or constructing in their minds, schemas or cognitive structures which constitute the meaning and understanding of their world” (p. 136). Constructivism maintains that individuals create or construct their own new understandings or knowledge through the interaction of what they already know and believe and the ideas, events, and activities with which they come in contact (Cannella & Reiff, 1994; Richardson, 1997). Learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving, and collaboration with others. In constructivism, active rather than passive involvement on the part of the learner promotes meaningful learning (Rogers, 1983). Students must be discovery-oriented and the content must appeal to the learner.

Constructivism provides a valuable framework for using technology in productive and interesting ways. Technology allows independent completion of work and allows students to be in control of their topics and explorations (Adams & Burns, 1999). Technology can enrich students’ use of a variety of resources and help them gain understanding about their world. Students can use technology to enhance their work and increase their connections with resources outside the school walls.

In applying constructivist theory as the framework for computer based technology implementation and leadership in education, Jonassen (2006) made the distinction that technology is a great tool to learn with rather than technology is a great way to teach.

When technology is implemented and utilized as a tool that aids instruction rather than as a replacement or substitute for instruction, the entire educational system benefits. Technology as a constructivist tool provides a means for individuals to construct meaning and applies to teachers who instruct students who learn, administrators who run schools, and superintendents who run districts.

TEXAS STaR CHART

Dougherty (2004) suggested that states use information technology as a tool to support school improvement under the No Child Left Behind Act. He advocated that a statewide longitudinal student information system and the use of information technology would provide diagnostic information to educators. The Texas Long-Range Plan for Technology was first adopted in 1988 (Texas Education Agency, 2006a). Since that time, several updates to the plan have been created. The most notable updates were in 2002, when the plan was revised to align the goals and objectives with the mandates from the No Child Left Behind Act of 2001, and again in 2006, when the United States Department of Education targeted new strategies and goals for schools in its 2004 National Education Technology Plan (Texas Education Agency, 2006a). The latest plan outlines the technology proficiencies, professional development, and technology resources required to achieve Texas' vision of academic excellence by the year 2020. The specific strands in the plan address 1) Teaching and Learning, 2) Educator Preparation and Development, 3) Leadership, Administration and Instructional Support, and 4) Infrastructure (Texas Education Agency, 2006a).

In order to assist schools in determining their progress toward meeting the goals of the long-range plan, the Texas STaR chart was developed and piloted in 1999-2001

(Texas Education Agency, 2006a). The STaR chart was designed as a tool to help districts in planning and assessing **S**chool **T**echnology **a**nd **R**eadiness with the long-range plan. In 2004, the Teacher STaR Chart was added as another technology planning tool to assess the progress in meeting state and federal requirements of student learning through the use of technology as well as identify needs for professional development and instructional goals (Texas Education Agency, 2006a). The Teacher STaR Chart became mandatory for all Texas teachers beginning with the 2006-2007 school year (Texas Education Agency, 2006c). This requirement allows Texas to report on the progress of fulfilling the requirements in the No Child Left Behind, Title II, Part D that all teachers should be technology literate and integrate technology across the curriculum (Texas Education Agency, 2006c). After teachers complete the Teacher STaR Chart, the aggregated data is reviewed by the principal, who then verifies that the summary is representative of the campus. The summarized data is used by campuses to submit the annual Texas Campus STaR Chart (Texas Education Agency, 2006b).

The six focus areas in the STaR Chart for the area of Teaching and Learning are patterns of classroom use, frequency/design of instructional setting using digital content, content area connections, technology applications TEKS implementation, student mastery of technology applications, and online learning. The Education Preparation and Development strand includes the focus areas of content of professional development, models of professional development, capabilities of educators, access to professional development, levels of understanding, and patterns of use and professional development for online learning.

The Leadership, Administration, and Instructional Support strand include the focus areas of leadership and vision, planning, instructional support, communication and collaboration, budget and leadership, and support for online learning. The final strand, Infrastructure for Technology, includes the focus areas of students per computer, Internet access connectivity/speed, other classroom technology, technical support, local area network/wide area network, and distance learning capacity.

Within each focus area, teachers and campuses rank their progress as being Early Tech, Developing Tech, Advanced Tech or Target Tech (Texas Education Agency, 2006c). This study only includes responses for three focus areas in the Teaching and Learning Strand: patterns of classroom use, frequency/design of instructional setting, and content area connections. The charts in Appendix C and D indicate the levels of progress for each focus that are in Teaching and Learning (Texas Education Agency, 2006c).

In the 2010 Progress Report on the Long-Range Plan for Technology, 2006-2010, TEA summarized the findings of the STaR Chart for each of the key areas of the plan. From 2009 to 2010, the number of teachers reporting themselves as Developing Tech for Teaching and Learning decreased by 6.4% while the number of teachers reporting at the Advanced Tech level increased by 7.3% (Texas Education Agency, 2010) as illustrated in Figure 1. This change indicates that more campuses are reaching the Advanced levels in the area of Teaching and Learning as reported by teachers.

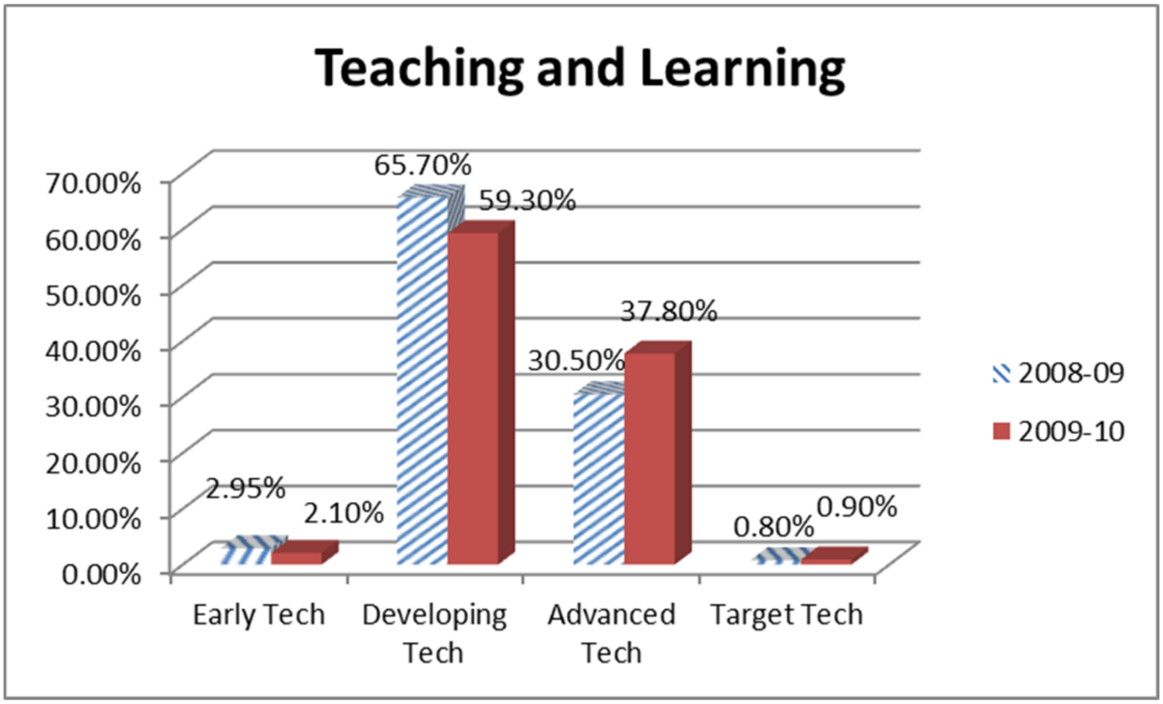

Figure 1. Frequency distribution of STaR chart results for the Teaching and Learning category

TEXAS ASSESSMENT OF KNOWLEDGE AND SKILLS (TAKS)

The Texas Assessment of Knowledge and Skills (TAKS) was designated by the Texas State Legislature to replace the previous state assessment (TAAS) in 2003 (Texas Education Agency, 2009). TAKS assessments were administered at grade levels 3 -11 in the subject areas of Reading, Writing, Mathematics, Science, and Social Studies. Of these, only Reading and Mathematics were administered consistently at every grade level. Achieving proficiency on the grade 11 assessments is necessary for high school graduation in Texas.

TEACHING AND LEARNING

The teaching and learning domain refers to how teachers teach and how students learn. Electronic technologies have been used in education since the 1950's. To provide

21st century learners with the needed technological skills, schools must move beyond the traditional methods of teaching and learning (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011). Thinking and problem solving, interpersonal and self-directional as well as digital literacy competencies can be gained through technology-enhanced learning experiences (Partnership for 21st Century Skills, 2012). There is abundant research that has shown student achievement, engagement, and motivation increase when teachers integrate technology into instruction (Funkhouser, 2002; Lin C. , 2006). However, other research results have not produced a strong case for the impact of technology on teaching and learning (Fitzgerald, Koury, & Mitchem, 2008; Lin, Ching, Ke, & Dwyer, 2007; Roblyer & Doering, 2010)

"Simply having students use technology does not raise achievement. The impact of technology depends on the way it is used and the conditions under which applications are implemented" (Roblyer & Doering, 2010, p. 13). In justifying the use of technology in education, Roblyer also cites a number of reasons to integrate technology including motivating students, enhancing instruction, making students and teachers work more productively, and helping students sharpen their information age skills.

Integrating technology into teaching and learning is the primary means by which technology can affect the academic achievement of students (U.S. Department of Education, 2009). Teachers and students having access to technology do not guarantee that student learning will improve. Technology must be part of the entire educational package (Bransford, 2000). Zucker (2008) pointed out that technology is only one factor in improving our education system for all students; he stated that although digital technology has enabled schools to change the way they operate in significant way, the impacts of technology will also depend on the choices of people (Zucker, 2008).

How technology integration is perceived by teachers could hinder implementation (Okojie, Olinzock, & Okojie-Boulder, 2006). A study by Leh (2005) revealed that teachers did not fully integrate technology into the classroom due to pedagogical and other constraints. The attitude of the teacher toward technology can be the most significant factor in student-centered technology use in the classroom (Palak & Walls, 2009). Teachers who practice technology integration tend to navigate toward a more student-centered approach to instruction (Matzen & Edmunds, 2007). Technology is "part of the instructional process and not an appendage to be attached at any convenient stage during the course of instruction" (Okojie, Olinzock, & Okojie-Boulder, 2006, p. 66).

Cravey (2008) studied whether the four domains on the Texas STaR Chart related to student achievement in math, reading, and social studies. The four domains of technology integration included teaching and learning, education preparation and development, administration and support services, and infrastructure for technology. Three control variables were used for the study: the percentage of economically disadvantaged students, the percentage of limited English proficiency students, and the per pupil expenditures for campuses. Schools in the study were Texas middle schools that included only grade levels six, seven, and eight. The data used for the study came from the 2004-05 school year. After data cleaning, 338 schools were used for the mathematics and social studies scores; for reading scores, a sample of 326 schools was used. Cravey's study used a hierarchical multiple regression procedure that allowed for the weighted linear combinations of the STaR Chart scores in conjunction with the control variables. Multiple regression analysis revealed no evidence to support a hypothesis that campus educational technology implementation was related to reading, mathematics, or social studies achievement.

A study examining the relationship between campus STaR Chart indicators and state accountability ratings was conducted by Brown (2009). Specifically, Brown's research included the following questions: (1) what is the administrator perceived level of digital literacy that is present in schools based upon their state accountability rating?; (2) are there statistically significant differences between the digital literacy levels of students according to their state accountability rating?; and (3) is there a statistically significant change in elementary students' levels of digital literacy over the period studied? Using four years of data from 2004-2008, Brown used a sample of all elementary schools in Texas and compared campus accountability ratings as based on TAKS scores with four focus areas in the Teaching and Learning strand of the STaR Chart: patterns of classroom use, frequency/design of digital content use, content area connections, and online learning. Each year of data was independently analyzed for trends. Trends from each year were compared to determine if a relationship existed between levels of digital literacy and student achievement. A chi square test was utilized to analyze the expected number of schools at various levels of technology implementation versus the observed number of schools actually at that level of technology implementation. The Wilcoxon signed-rank test was used to investigate if a statistically significant change in elementary students' levels of digital literacy existed over the period studied.

Brown's research revealed that the reported mean scores of recognized and exemplary schools surpassed the scores of unacceptable and acceptable schools, indicating a relationship between teaching digital literacy skills and increased student achievement. In all eight cases measured, a significant relationship was found with a small to moderately small effect size for the four focus areas. The highest effect size was evidenced in the content area connections focus and the lowest effect size was found in the online learning focus. Finally, a discrepancy was found in the changes in the levels of digital literacy. Over the period studied, patterns of classroom use and online learning increased for elementary campuses. However, design/frequency of instructional setting using digital content and content area connections decreased over the same time period.

Technology usage assumes that technology and the required infrastructure are available for use in classrooms and accessible to teachers and students (Lynch, 2006). Technology is often seen as a finished product that can be inserted in to the educational equation to generate a desired effect. The implementation of computers are usually expressed and assessed in terms of computer-to-student-ratio. This approach fails to address the complexity of technology usage since how technologies are used is usually neglected in the technology affect equation (Lynch, 2006).

For many years, the idea of technology in schools always meant computers and software, or specifically, investments in items that grew obsolete quickly and had somewhat limited uses. More recently, this has changed to include the Internet and its potential resources, databases, and unlimited information. Now, however, we have an expanded view of what technology in education means. No longer are we limited to the software someone has designed, the limited uses of computers that others have predetermined, or the resources someone else has put on the Web. Now we have an unlimited combination of resources (human and nonhuman), tools, and the creativity to teach in ways that we have only dreamed about. These tools include hardware that is easily customized. Smart boards, software that learns what a particular student needs, and online tools that can approximate the expensive software we used to require in schools are all now widely available, useful, and freely available on the Internet to use in supporting strong student outcomes. It is not enough, however, to know that these tools exist; it is essential that we consider the nature of engaging students in their own learning.

A critical issue of efficiently integrating computer-based technology is the administrative use of technology to enhance instruction for student achievement. Data systems to track student progress, Pod casts, wireless Internet connections, and student media presentations are examples of how technology can improve student achievement. (Li, 2007; O'Bannon & Judge, 2004).

In 1983, 40% of high school seniors said their schoolwork was "often or always meaningful," but in 2000, only 28% gave this response (Oppenheimer, 2003, p. xiv). This trend suggests an alarming situation. Additionally, more than 70% agreed that "most students do the bare minimum they need to get by" (Stoll, 1999, p. 32). Zucker (2008) pointed out that technology is only one factor in improving our education system for all students but went on to state that the role of technology in the transformation of schools will depend on the choices of people.

PATTERNS OF CLASSROOM USE

The patterns of classroom use domain relate to whether the teacher is using technology for administrative tasks and instruction or whether curriculum activities are integrated with technology for students to gain knowledge and understanding (Texas Education Agency, 2006c). The integration of technology in the classroom has been shown to help increase student knowledge attainment, create unique constructivist events, and provide students with opportunities to experience learning in an innovative manner (Becker, 2007). Other studies provide evidence against the gains to be made with educational technology (Schmoker, 2006). Cuban (2001) has been highly critical of the use of computer technology in the classroom stating that money spent on computers could have been better spent on other aspects of education. Cuban (2006) suggested that any achievement gains could more easily be attributed to teachers than technology. Recent studies to determine the impact of technology integration on student learning have not produced positive results (Sisco, 2008). Sisco found no significant correlation between the level of technology integration and student achievement of middle school students in Tennessee.

Technology hardware and software. Technology hardware in the classroom can take the form of desktop computers, laptops, mobile devices, interactive whiteboards, student response pads and digital projectors. Software used by teachers or students can be used to organize, evaluate or create information. Word processing, spreadsheets and multi-media presentation are examples of software. Computer-assisted instruction (CAI) software provides direct instruction to students. However, some research has suggested that CAI programs do not provide gains in student achievement (Campuzano, Dynarski, Agodini, & Rall, 2009; Dynarski, et al., 2007). In addition, Oppenheimer (2007) contended that software companies utilize faulty research to show that the program can produce gains for students, especially in math and language.

Lopez (2010) studied the impact of interactive whiteboard technology on decreasing the achievement gap on English Language Learners (ELL) in mathematics and reading. The project achieved performance parity for third and fifth grade ELL math students. However, results were mixed for ELL students in reading.

Technology use. The important point in the implementation of technology is not the quantity of technology use but how the technology is used. A survey of high-technology schools found that students can use technology to problem solve, participate in interactive learning, practice for standard tests, work collaboratively and self-direct learning (Sweet, Rasher, Abromitis, Johnson, & North Central Regional Educational Lab, 2004). Lei and Zhao (2007) found that how technology was used had the greatest impact on improving achievement for middle school students. In his study of the National Assessment of Educational Progress (NAEP) scores, Wenglinsky (2006) suggested that teachers should not plan lessons around a computer but assume that students will use technology to perform their learning tasks. When teachers utilize technology to promote higher-order thinking skills, the impact on elementary students' achievement was positive.

Recent surveys of teacher use of technology found an increase in teachers using technology as a productivity tool (Means, 2010). However the level of technology-based activities for students did not increase during the same time period of 2005 – 2007 (Bakia, et al., 2009). A strong positive correlation exists between technology integration practices and a constructivist view of learning by teachers (Levin & Wadmany, 2006). Some recent research suggests that a teacher's technology-integrated experience is also correlated with student-centered learning beliefs (Judson, 2006). Classroom activities tend to be more student-centered when students use word processing and presentation software or the Internet to create products (Inan, Lowther, Ross, & Srahl, 2010). As of 2009, teachers reported that computers were used during instruction often (40%) or sometimes (29%) (Gray, Thomas, & Lewis, 2010). Few technology supported learning methods have been accepted by the majority of teachers (Means, 2010). Means also suggested that teachers will only integrate technology into instruction when they are convinced of the positive impact on student learning. Others counter that only when teachers actually integrate technology into the classroom does the constructivist belief emerge; suggesting that change in beliefs follows change in practice (Levin & Wadmany, 2006).

In the Apple Classrooms of Tomorrow (ACOT) initiative, teachers used computers to assist in cooperative learning and long-term project (Sandholtz, Ringstaff, & Dwyer, 1997). While students appeared to experience higher order thinking and problem solving, there was no difference in the achievement of students on standardized tests from the control group (Schacter, 1999).

The Technology Immersion Pilot (TIP) created by the Texas Education Agency, provided students with wireless mobile computing devices and technology-based learning resources in addition to professional development for educators. A longitudinal study of this project found no statistically significant effect of technology immersion on students' reading and mathematics achievement (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011). However, the achievement gains were consistently positive across all cohorts, especially for students from poverty.

In order for technology to impact student learning, teachers must be properly trained on the concepts and implementation of related hardware and software (Becker, 2007; Cifuentes, Maxwell, & Bulu, 2011; Martin, Strother, Beglau, Reitzes, & Culp, 2010; Wenglinsky, 2005). Teachers need ongoing professional development, collaboration with colleagues, modeling of best practices, and institutional support to ensure effective technology integration (International Society for Technology in Education, 2009).

One program that has attempted to assist teachers with integrating technology and student-centers learning in the classroom is the enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS). The goals of eMINTS professional development are to support high-quality lesson design, promote inquiry-based learning, create technology-rich learning environments, and build community among students and teachers (eMINTS National Center, 2012). Elementary school students in eMINTS classrooms consistently outperform non-eMINTS students in the areas of communication arts, mathematics, science, and social studies (Beglau, 2007; Huntley & Greever-Rice, 2007).

FREQUENCY/DESIGN OF DIGITAL CONTENT USE

The frequency/design of digital content use relates to the access of technology by students and teachers (Texas Education Agency, 2006c). Access to technology is a crucial component of technology integration in the classroom. As of the 2008, every public school in the United States had computers with Internet access with an average of students to Internet access computers of 3.1 to 1 (Gray, Thomas, & Lewis, 2010). However, only thirty-nine percent of public schools had wireless network access for the entire school. In order to address the issue of computer and Internet access, schools are initiating one-to-one computer-to-student programs (Dunleavy, Dexter, & Heinecke, 2007).

Middleton and Murray (1999) examined the impact of instructional technology on reading and math achievement and found that student achievement was affected by how much technology a teacher implemented in the classroom. However, Lei and Zhao (2007) found that achievement was not impacted by the amount of technology utilized but by the types of tasks assigned to students when using the technology.

Garthwait and Weller (2005) found that the use of a one-to-one, student-to-computer ratio did not automatically shift instruction to a student-centered format. In contrast, Queener (2011) found a significant positive impact on achievement when a one-to-one computer program was implemented for eighth grade math students. Collaboration with others is necessary to develop authentic learning activities. Programs focusing only on the purchase of technological hardware without changes in instructional strategies will struggle to improve achievement.

Studies have found that schools with a lower ratio of students to computer outperformed districts with higher ratios (McLeod, 2011; Penuel, 2006). Some schools use checked-out laptops to address the gaps in computer access (Roberts, Foehr, & Rideout, 2005). According to Wells, Lewis and Green (2006), approximately 10% of schools had a laptop check-out program in 2005. Although laptop initiatives can address some access issues, a one-to-one program ensures that students have access to a computer every day. However, other studies have found the amount of time students use technology does not have a significant impact on student gains (Dynarski, et al., 2007)

(Means, 2010). Means suggested that the point in the school year when software began to be used was more important than the amount of time students spend using specific software.

Access to technology is broader than simply how many computers are in a classroom. In the Internet age, the infrastructure to provide online access to computers and mobile learning devices is also critical. With the advent of mobile learning devices, handheld devices such as iPads and iPod Touch, provide anytime-anywhere access for students and teachers.

Schools without funds to purchase educational software have a wealth of free resources available through the Internet. In addition, a classroom network that connects portable student learning devices can support student engagement and understanding (Penuel, Roschelle, & Singleton, 2011; Roschelle, Penuel, & Abrahamson, 2004).

CONTENT AREA CONNECTIONS

The content area connections domain relates to whether technological tools are used by teachers and students to analyze and synthesize data, communicate knowledge and understanding as well as collaborate within the learning community (Texas Education Agency, 2006c). Many studies have attempted to explain the impact of technological learning on the acquisition of content knowledge. However, since this study focused on the content areas of Reading and Mathematics, only studies related to these content areas will be reviewed.

Numerous researches have proposed that Technological Pedagogical Content Knowledge (TPACK) is a complex interaction among content, pedagogy and technology knowledge requiring that teachers have a deep basis in each area of technology, pedagogy, and content to effectively approach how technology can impact problems students face with learning (Niess, 2011; Koehler & Mishra, 2009; Pierson, 2001). The technology choice by educators can enhance or limit the types of content being taught. Conversely, some content can limit what technologies would be useful in instruction (Koehler & Mishra, 2009). Therefore, teachers need to be proficient at not only their content they teach but also how the application of technology can be applied and possibly change the pedagogy of the subject. A technology solution for one content area will not necessarily be the same solution for another subject (Mishra & Koehler, 2006). The curriculum content should serve as the primary focus of instruction with the technology application serving as a secondary focus (Harris & Hofer, 2009). The content area connections domain may also be an indicator of whether teachers have the experiences in learning with technology to prepare them to teach content with technology (Niess, 2011).

Mathematics. No Child Left Behind developed a goal that technology would be integrated in curriculum and instructional strategies in all schools. The "Principles and Standards for School Mathematics," developed by the National Council for Teachers of Mathematics, states that "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (National Council for Teachers of Mathematics, 2000). Appropriately implemented, technology integration can change how mathematics is taught, focusing on conceptual understanding by students as opposed to rote procedural skills (Guerrero, 2010). There are a variety of ways that technology can be integrated into the math classroom. Math specific technology can include calculators, computer algebra systems, math software, networked classrooms as well as Web-based programs (Lynch, 2006). Students can create using

Geometer's Sketchpad, a math-specific software, and virtual online animations to process analysis of math situations. Online research allows students to collect data in real-world contexts. Spreadsheet software allows students to perform more complex mathematical computations than could be done by hand (U.S. Department of Education, 2009). Integrating technology into mathematics instruction can enrich or totally renew the meanings and understandings students acquire (Laborde, 2007). In mathematics education, the policy message is that technology can and should be used to enhance student mathematics learning (Lynch, 2006). However, the teaching of mathematics should not include technology in all circumstances. Integrating technology in mathematics instruction should be diligently analyzed taking into account sound teaching and learning strategies (Laborde, 2007).

The use of manipulatives is widely accepted as a necessary tool in helping students understand mathematics. Computer-based virtual manipulatives are being used in the classroom more with the development of a web-based National Library of Virtual Manipulatives developed at Utah State University with support from the National Science Foundation (Utah State University, 2010). One study assessed the effectiveness of physical and virtual manipulatives on sixth grade students' visualization and spatial reasoning skills (Drickey, 2006). Using a quasi-experimental pre-test-post-test control-group design, students were assigned to one of three treatments: (1) virtual manipulatives; (2) physical manipulatives; and (3) no manipulatives. Results for differences in mathematics post-test mean scores in the three treatment groups were not statistically significant (Drickey, 2006).

Mathematical concepts can be deeply renewed with the assistance of digital technologies. Technology in mathematics instruction can provide the ability to represent mathematical ideals in a variety of forms and then manipulate these representations (Laborde, 2007). Dynamic geometry environments (DGN), such as *Geometer's Sketchpad*, *Cabri Geometry*, and *Geometric Supposer for Windows*, transform static drawings to manipuable, dynamic and interactive objects (Laborde, 2007).

Integrated Learning Systems (ILS) refers to computer software programs that provide tutorial instruction at different grade levels and keep records of student progress. Kulik (2002) reviewed sixteen studies on Integrated Learning Systems (ILS) on mathematics achievement. Each study found that scores on math assessments were higher in the group taught with ILS with nine of the studies being statistically significant.

Wenglinsky (2005) found that if computers were used in problem posing, problem solving, and exploratory ways, then "computer use is positively associated with student performance," but when it was used for drill and practice, students did not benefit from the technology (p. 77). Active learning and problem solving do have the potential for increasing not just math scores but also mathematical understanding, especially when supported by the use of technology (Schrum & Levin, 2009).

Computer-aided instruction (CAI) is described as the use of a computer to provide course content in the form of drill, practice, tutoring and/or simulations (Roblyer & Doering, 2010). In CAI, visual information is presented which the student reads or observes. Studies have found that CAI had a positive effect on student achievement (Kausar & Gujjar, 2008; Traynor, 2003). Lewis (2010) reported that fourth grade students using *Successmaker*, a type of CAI program, for math intervention showed significant gains compared to a control group.

The ability to network calculators has revolutionized the learning of mathematics (Penuel, Roschelle, & Singleton, 2011). Calculators can be networked together allowing the teacher to display student work or student responses for the entire class. Wireless networks such as the Texas Instrument Navigator system, allow for real time identification of student progress, positive impact on student engagement, and opportunities for instant feedback (Guerrero, 2010). Networked calculators were found to provide a significant positive effect on student achievement in mathematics (Penuel, Roschelle, & Singleton, 2011).

Reading. The nature of reading lends itself to the interaction with digital technology. As with mathematics, the English Language Arts Standards state that students should use technology (National Council of Teachers of English, 1996). Databases, computer networks, video, and word processing software provide students with the ability to gather and synthesize information and communicate their knowledge. Students can use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge (Maninger, 2006). Software can be used to assist with reading comprehension, writing, and spelling. Software may also promote creativity in writing through the use of digital storytelling and movie development (Schrum & Levin, 2009). A meta-analysis of students learning to write with computers suggest that students using computers when learning to write were more engaged and produced written work of higher quality (Goldberg, Russell, & Cook, 2003). Some research has suggested that at-risk students benefit more than non-at-risk students when English is taught in a technology-rich classroom (Maninger, 2006).

The effectiveness of technology for reading outcomes was published in a large-scale, randomized evaluation of modern computer-assisted instruction programs by Dynarski (2007) and Campuzano (2009). Teachers were randomly assigned to use any of five first grade programs and four fourth grade programs, or to control groups. At both grade levels and in both years of the evaluation, effect sizes were near zero. The overall effect size was +0.04 for first grade and +0.02 for fourth grade. The second year evaluation computed effect sizes for each CAI program separately, and these comparisons found none of the programs had notable success in reading. Another meta-analysis in 2011 suggested that education technology generally produced a positive, though small, effect size (ES=+0.16) (Cheung, 2011). While this effect is much larger than the CAI models by Dynarski and Campuzano, "similar studies of traditional, supplementary CAI studies that used random assignment … found smaller effect sizes than other studies" (Cheung, 2011, p. 15).

Cheung's (2011) study also evaluated the types of computerized intervention employed. Specifically computer-managed learning, innovative technology applications, comprehensive models and supplemental technology intervention types were examined. Supplemental programs, such as *Destination Reading, Plato Focus, Waterford, and WICAT*, provide additional instruction at a student's assessed levels of need. These were the types of program evaluated in the Dynarksi and Campuzano studies. Innovative technology applications included *Fast ForWard, Reading Reels*, and *Lightspane*. Computer-managed learning systems included only *Accelerated Reader*. Comprehensive models, represented by *Read 180, Writing to Read*, and *Voyager Passport*, are methods that use computer-assisted instruction along with non-computer activities as students' core reading approach. These comprehensive models serve as integrated literacy interventions, combining computer, and non-computer instruction in the classroom. The 18 comprehensive model studies produced the largest effect size, +0.28, which the six innovative technology applications and four computer managed learning programs producing similar effect sizes of +0.18 and +0.19 respectively. The average effect size for the 57 supplemental technology programs was only +0.11. Although the comprehensive approaches have a greater impact on reading outcomes than the ordinary CAI models, studies do not isolate the unique contribution made by the use of technology (Cheung, 2011).

McAlver (2008) found few significant effects on the performance of elementary students in language arts when a multi-faceted technology program was used as a teaching and learning tool. McAlver's results support Oppenheimer (2003) in suggesting that there is little evidence to link the use of technology with improvements in learning outcomes. Similarly, an examination of Apple Classrooms of Tomorrow (ACOT) schools showed no significant difference in student achievement on reading and language between ACOT students and national statistics (Baker, Gearhart, Herman, & University of California, 1993). However, the ACOT approach had a positive impact on student attitudes toward school and the quality of teachers' instructional practices.

The accessibility of productivity applications such as Microsoft Office and Google Docs can provide students with tools to aid in writing. Additionally, software that moves beyond the drill-and practice nature of earlier programs and develops prereading and pre-writing skills in students (e.g. *Kidspiration, Accelerated Reader, Write to Read),* have been developed (Kulik, 2003). Kulik reviewed twelve studies on the impact of *Write to Read*, concluding that it has the greatest impact in kindergarten students. Kulik also reviewed recent studies on the impact of reading programs such as *Accelerated Reader* (AR). Such programs assist students in the selection of appropriate reading material, and test them on their reading comprehension. Programs like AR also keep ongoing records of student progress and provide immediate feedback to teachers and students. Research in three controlled comparisons suggests that these programs can have a significant impact on reading achievement; however, Kulik (2003) conceded that much more research is needed to establish these programs as pedagogically sound.

TECHNOLOGY INTEGRATION LEADERSHIP

The global bank of knowledge and its availability have forced school leaders to rethink how students learn and relate to the world (Wagner, 2008). In order for technology integration to be successful, the school must have an effective leader. School leaders need a solid research base to move beyond the traditional role of school leaders (McLeod, 2007). Administrators must provide the support for technology integration as well as involve the entire educational system to utilize technology towards improving student achievement (Wayman & Stringfield, 2006). Hargreaves and Fink (2006) promoted a focus on sustainable leadership when implementing technology, not on the specific technology that is being implemented. Establishing professional learning communities (PLC) is a structure that can foster a technological culture. PLCs require learning by doing by providing the tools necessary for teachers to accept technological change (DuFour, DuFour, R., Eaker, & Many, 2006). Sustainable technology leadership can thrive within the structure of PLCs.

Sanders (2006) called for a more clearly defined structure for education technology leadership and proposed leadership initiatives that aim to develop a culture that fosters and embraces the implementation of technology and identifies learning outcomes that can be achieved with technology. Bain and McNaught (2006) investigated the beliefs and practices of teachers who utilize technology in their teaching. They revealed that teachers were reluctant to change and hesitated to embrace practices that involved the implementation of technology.

Chang, Chin and Hsu (2008) determined that a strong correlation exists between a school's level of technology integration and the school's technology leadership. They provided a framework to define effective technology leadership. The elements of this framework include vision, planning, and management; staff development and training; support for fundamental equipment; evaluation and research; and interpersonal and communication skills (Chang, Chin, & Hsu, 2008). Beyond vision and planning, school leaders must make staff development and training a priority. Aligning professional development to meet the technology needs of teachers will help to improve instructional performance (Guthrie & Schuermann, 2010). The management element of school leaders includes not only the management of resources but also the monitoring of teacher's technology use of technology to ensure successful technology integration (Chang, Chin, & Hsu, 2008).

Effective technology integration is dependent on how budgets are spent (Liu & Huang, 2005). Administrators must ensure that technologies are accessible to students.

In doing so, educational leaders must define the notion of accessibility. The notion of accessibility is more than just providing computer systems in classrooms. Students need the opportunity to become literate in technology including the ability to interpret information gathered with educational technology (Hawkins, 2005).

SUMMARY

Technology cannot in itself provide the changes needed to improve education. Educational leaders need to apply the lessons learned from research to implement constructivist teaching with technology that motivates students to increase learning.

The review of literature provided insight as to types of technology integration that exist and the impact on student achievement. Two specific studies utilized the STaR Chart data to evaluate the effectiveness of technology integration. Cravey's (2008) study of 326 schools in Texas found no evidence to support that technology implementation was related to reading, mathematics, or social studies achievement. Brown's (2009) research of Texas elementary schools indicated a relationship between teaching digital literacy skills and increased student achievement, with the highest effect size evidenced in the content area connections focus. Given the mixed reviews, further research provided in this study is needed to analyze the impact of technology on student learning.

CHAPTER 3
Methodology

This study examined the relationship between the degree to which schools have integrated technology into teaching, learning, and student achievement. Chapter III includes sections on research questions and hypotheses, population/sample, instrumentation, procedure and time frame, and research design and analysis.

Three focus areas in the STaR Chart for the strand of Teaching and Learning were examined for technology integration. These areas contain patterns of classroom use, frequency/design of instructional setting using digital content, and content area connections. Specific questions identified included: (1) How does the degree of implementation in the three focus areas relate to student achievement in math?; (2) How does the degree of implementation in the three focus areas relate to student achievement in reading?; and (3) Is there a difference in the achievement of students in reading and math at campuses with target levels of integration in the three focus areas? These questions dealt with whether the level of implementation has an impact on student achievement in Texas middle schools.

Research Questions and Hypotheses

1. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores?
2. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital

Content, and student achievement in Reading as measured by grades six through eight TAKS scores?

3. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores?
4. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores?
5. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores?
6. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores?

Using the research questions as a guide, the following research hypotheses were developed:

H_O^1: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_O^2: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional

Setting Using Digital Content, and student achievement in Reading as measured by grade six through eight TAKS scores.

H_O^3: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_O^4: There is no statistical difference (α= .009) between levels of technology the integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_O^5: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_O^6: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

POPULATION/SAMPLE

This study included achievement scores from Texas middle schools, which contain only grade levels six, seven, and eight. Achievement scores selected were for the aggregate campus score for reading and mathematics, since these two subjects are the only ones administered across every grade level. Since the TAKS Reading and Mathematics assessment are given at grades six, seven, and eight the campus aggregate achievement is an appropriate measure for the entire middle school campus. Elementary students are only assessed in grades three four and five, and a campus aggregate score for an elementary school is not a reflection of the entire campus. Alternately, high school campuses only measure achievement with TAKS Reading and Mathematics for grades nine, ten and twelve (Exit Level). Therefore, the data from the middle school campus is most reflective of the achievement of the entire campus.

With the onset of adolescence, middle school students face challenges in persistence and motivation. Technology integration can have a significant impact on the student persistence that could impact achievement. An entire campus can be affected by technology integration and isolating a particular grade would not serve the needs of this study.

The study used data from the 2010-11 school year, the most recent data available for the Texas Campus Student Technology and Readiness (STaR) Chart and Texas Assessment of Knowledge and Skills (TAKS). Using data from the Texas Education Agency website, there were 1,117 middle school campuses for the school year 2010-11. These 1,117 middle schools served as the population sample. Achievement scores were selected for all students in grades six through eighth grade for both Math and Reading. In grades six through eight subjects tested included Reading, Writing, Mathematics, Social Studies, and Science. However, only the Reading and Mathematics test were administered for all students in grades six through eight.

INSTRUMENTATION

No Child Left Behind, Title II, Part D required states to measure the impact of efforts to improve student learning through the use of technology (Texas Education Agency, 2006c). The Texas Teacher STaR Chart is a self-assessment questionnaire completed by teachers to assess the perception their educational technology implementation level in four key areas. Principals then use the summarized teacher responses to determine each indicator score. The STaR Chart is used to address the impact of technology integration as well as identify needs for professional development in the area of technology.

The six strands in the STaR Chart for the area of Teaching and Learning are patterns of classroom use, frequency/design of instructional setting using digital content, content area connections, technology applications TEKS implementation, student mastery of technology applications, and online learning. The other strands, Education Preparation and Development, Leadership Administration and Instructional Support, and Infrastructure for Technology are not included in this study. While these areas are critical to appropriate technology integration, this study only looked at the teacher's role of integrating technology into teaching and learning by examining the campus level of technology integration through of three focus areas: content area connections (TL1), frequency/design of the instructional setting using digital content (TL2), and patterns of classroom use (TL3).

Within each focus area, teachers and campuses rank their progress as being Early Tech (a score of 1), Developing Tech (a score of 2), Advanced Tech (a score of 3), or Target Tech (a score of 4) (Texas Education Agency, 2006c). The tables in Appendix C and D outline the guidelines teachers use to evaluate their own progress.

The STaR chart data was compared with the percentage passing scores on the TAKS Reading and Mathematics assessment for students in grades six through eight. TAKS consists of subject area assessments given to Texas public school students in grades three through eleven. The framework for the TAKS objectives is provided by the

Texas Essential Knowledge and Skills (TEKS). TEKS outline the instructional standards for each subject. The subjects assessed by TAKS vary for each grade level; however, Reading and Mathematics are given at every grade level. Therefore, only Reading and Mathematics were analyzed in this study. TEA compiles a state-wide report with percentage passing scores for each campus. Since the STaR chart and TAKS data are reported by campus, this data was easily combined.

VALIDITY AND RELIABILITY

The reliability of the STaR Chart data is limited to the level of accuracy and standardization of answers from teachers and principals. STaR Chart data is self-reported and the levels of integration are a self-analysis by teachers. Persons completing the survey may not accurately assess the technology component in each area. Nonetheless, the STaR Chart is the only statewide assessment of technology integration in the state of Texas. In addition, Texas Education Agency (TEA) requires campuses and districts to complete and submit the data in order to be eligible for technology grant programs.

The STaR chart was designed as a tool to help districts in planning and assessing School Technology and Readiness with the long-range plan. The Teacher STaR Chart became mandatory for all Texas teachers beginning with the 2006-2007 school year (Texas Education Agency, 2006c). This requirement allows Texas to report on the progress of fulfilling the requirements in the No Child Left Behind, Title II, Part D, that all teachers should be technology literate and integrate technology across the curriculum (Texas Education Agency, 2006c). With the state of Texas utilizing the STaR chart for these purposes, a significant amount of validity and reliability has been placed in the instrument. Standardized rubrics for evaluation of each category provide internal reliability of the instrument.

The TAKS instrument is used to make inferences about a student's knowledge and understanding of the Texas Essential Knowledge and Skills (TEKS). Since the assessment is standards-referenced, test validity is directly connected to the content. Beginning in 2001, committees of educators and test development specialists have reviewed TAKS items for content and bias (Texas Education Agency, 2007b). In addition data from field testing is also reviewed. A validity study in 2004-2005 to correlate performance on the exit level TAKS with national testing programs found a positive correlation (Texas Education Agency, 2007b). A grade correlation study in 2008 found students who met the standard on TAKS were also likely to have passed their classes (Texas Education Agency, 2007b). Reliabilities for TAKS assessments ranged from .87 to .90 on the Kuder Richardson Formula 20 (KR 20) test for internal reliability with most internal consistency reliabilities being in the high 80s (Texas Education Agency, 2007).

PROCEDURE AND TIMEFRAME

To investigate the relationship between the level to which campuses have integrated technology into teaching and learning and student achievement, data was needed for both campus technology integration and campus-level student achievement. Campus STaR Chart data was used to measure technology integration and student achievement was measured by the percentage of students on a campus passing TAKS, specifically Reading and Mathematics for all students in grades six through eight. All data was obtained electronically from the publically available Texas Education Agency

(TEA) websites for the year 2010-11. Two electronic files downloaded included data from the Academic Excellence Indicator System (AEIS) and the STaR Chart data. These files were imported into Microsoft Excel and merged using the VLookup function. The Campus ID number was used as the lookup value to merge the dependent variables, Mathematics and Reading achievement, from the AEIS, and the independent variables from the STaR Chart data for each campus.

DATA ANALYSIS AND RESEARCH DESIGN

Reading and Mathematics TAKS achievement scores for Texas middle schools that include grade levels six, seven, and eight for the school year 2010-11 were compared with the 2010-11 Texas Campus Student Technology and Readiness (STaR) Chart in the area of Teaching and Learning (TL). STaR Chart ratings in the categories of Patterns of Classroom Use (TL1), Frequency/Design of Instructional Setting Using Digital Content (TL2), and Content Area Connections (TL3) were compared with the TAKS results by campus. This data was downloaded electronically from Texas Education Agency (TEA) websites and organized in a spreadsheet program. A summary table was created to show percentages for the three focus areas of Teaching and Learning and the corresponding four levels of integration.

The two dependent variables were the percentage of students in grades six through eight on a campus passing the TAKS test for Mathematics and Reading. The three independent variables were the first three categories of technology integration on the STaR chart, TL1 (patterns of classroom use), TL2 (frequency/design of instructional setting using digital content), and TL3 (content area connections).

The AEIS file contained 11 campuses identified as alternative education settings that do not fall under the same accountability as other campuses. Therefore, these 11 campuses were eliminated from the data file. In addition, the AEIS reports employ masking of performance to comply with the Family Educational Rights and Privacy Act (FERPA) when a campus size is too small or when all students pass or fail an assessment. The masking rule was applied to the data that affected 4 campuses. After these data preparation steps were complete, a total of 1,106 campuses contained merged data for the study.

Research Question 1 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores? The first research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Patterns of Classroom Use (independent variable), and student achievement in Reading as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

Research Question 2 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores? The second research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Frequency/Design of Instructional Setting using Digital Content (independent variable), and student achievement in Reading as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

Research Question 3 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores? The third research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Content Area Connections (independent variable), and student achievement in Reading as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

Research Question 4 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores? The fourth research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Patterns of Classroom Use (independent variable), and student achievement in Mathematics as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

Research Question 5 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores? The fifth research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Frequency/Design of Instructional Setting using Digital Content (independent variable), and student achievement in Mathematics as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

Research Question 6 Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores? The last research question associated the integration of educational technology as measured by scores on the Campus Texas STaR Chart, Content Area Connections (independent variable), and student achievement in Mathematics as measured by the percentage of students passing TAKS (dependent variable) for students in grades six through eight.

STATISTICAL METHODOLOGY

The following statistical methodologies were employed in order to evaluate the research questions and associated hypotheses in this study. All statistics were conducted using SPSS version 20 (IBM Corporation, 2011). Graphs were created using SPSS or Microsoft Excel, 2007.

First, procedures were used to describe the data that were obtained for this study. For the three focus areas of technology integration, frequency distributions and bar graphs were created to display the distribution of levels of integration. Spearman rank correlation coefficients were used to determine the relationship between the levels of integration in the three areas. The Spearman rank correlation coefficient is a non-parametric alternative to the Pearson correlation coefficient that is suitable for ordinal data. In this analysis, the data are first ranked and then the Pearson correlation is computed on the ranks (de Smith, 2011; IBM Corporation, 2011). In order to evaluate whether there were differences in the distributions of scores between the three areas of technology integration, Friedman's two- way ANOVA test by ranks was used. This test is a non-parametric alternative to the repeated measures two-way ANOVA. In this test, the values of the variables are ranked for each case and the mean rank is calculated for each variable over all cases. The test statistic is compared to the chi-square distribution to obtain the significance level (de Smith, 2011; IBM Corporation, 2011).

The data obtained for the dependent variables consisted of the percentage passing the Reading and Mathematics achievement tests. Descriptive statistics including the mean, standard deviation (SD), and range were calculated to describe the scores. Distribution histograms were used to display the values obtained.

The campus size for each school was also obtained from the TEA website. Due to the wide variation in the campus sizes, the percentages of students passing the Reading and Mathematics tests summarized vastly different numbers of students. For example, 60 of 100 students passing, or 600 of 1000 students passing would both give the same passing rate of 60%, yet the numbers underlying those percentages were clearly not equivalent. The use of a probit procedure to analyze the research questions was used to handle the discrepant underlying sample sizes. For this analysis, the *number* of students passing per school was required. This was calculated by multiplying the percentage passing in each school by the campus size, and then rounding this result to the nearest integer. To describe these data, the descriptive statistics of mean, SD, range, and distribution histograms were calculated on the number of students passing the Reading and Mathematics achievement tests.

Pearson correlation coefficients were used to determine the degree to which scores on the Reading and Mathematics tests were interrelated. The correlation was computed on both the percentage passing and the number of students passing. Then paired-samples t-tests were used to determine whether the mean number (or mean percentage) of students passing the Reading or Mathematics achievement tests differed.

A number of statistical procedures were computed to address the research questions and hypotheses. The outcome measures in this study were the percentage passing the Reading and Mathematics achievement tests. These data are expressed in the form of *proportions* or *probabilities*; that is the percentage passing is dependent on the number of students passing the test, and the total number of students in the school. This is an example of data that follow the binomial probability distribution, which is used to describe the probability of x successes (e.g., number of students passing the test) out of n trials (e.g., number of total students) (de Smith, 2011). Binary data pose a problem for linear modeling for a number of reasons (Fox, 2010). For one, the distributions are Bernoulli and not normal (although they may approximate the normal distribution when sample sizes are large and the probability is close to 0.5) (de Smith, 2011). Binomial proportions have a finite range between 0 and 1 inclusive. In other words, a percentage score cannot be less than 0% or greater than 100%. However, the estimated parameters of a linear model may predict values less than 0 or greater than 1 (Fox, 2010). A non-linear association among the probability values and the independent variable may be expected in some cases, which violates the assumptions of the linear model. For example, a change in x may be anticipated to have a smaller effect when the probability is close to 0 or 1 than when it is in the middle of the range (i.e., an S-curve shape rather than a linear line). In addition, the variance of a binomial proportion is defined as $np(1-p)$, where n is the sample size and p is the probability of "success" (de Smith, 2011). Thus, for any given sample size the variance changes with the value of p – small or large values have low variance, and the variance is at its maximum when probability levels are near 0.5 (de Smith, 2011). This is a violation of the homogeneity of variance assumption of the general linear model. Due to these issues, modeling the data in this study using the binomial distribution, rather than the normal distribution and linear function, provided the most correct method of data analysis. Since the campus size for which each percentage was calculated on was also available from the TEA website, the number of "events" or "successes", which were the number of students passing, in the number of "trials", which were the total number of students, could be modeled using the binomial distribution and the generalized linear model.

The generalized linear model (GLIM) is an extension of the general linear model (GLM) that allows for non-normal distributions, count data, proportion data, and many other statistical models (de Smith, 2011; IBM Corporation, 2011b). It consists of three components: a probability distribution (normal, binomial, gamma, etc.), a linear predictor, and a link function that associates the mean of the distribution function to the linear predictor. For example, the form for a regression equation in the general linear model (GLM) is: $y = \alpha + \beta x + \varepsilon$, where y is the dependent variable, β is the regression parameter that must be determined, and ε is the error (de Smith, 2011). The probability distribution in this situation is the normal distribution, the form βx is the linear predictor, and the link function is the identity function, $f(x) = x$ (meaning no transformation).

For the binomial distribution, two non-linear link functions are commonly employed: the logistic function and the probit function. Both of these functions map the real number line to between 0 and 1 inclusive, have similarly shaped S-curves, and produce similar results. However, they differ in their theoretical underpinnings. If the observed data is assumed to itself come from a hidden continuous (normal) variable, then the probit model is preferred (Hanneman, 2013). The binary outcomes in this study (passing or failing the achievement test) are actually artificial dichotomizations of continuous measures, the probit link function was selected for these analyses. In other words, the Reading and Mathematics test results are not based on a single item Bernoulli trial. Rather, a cut-off score has been selected so that scores below the cut-off are counting as “failing”, and scores above the cut-off are counted as “passing”, but there is actually a range of possible scores underling this binary decision. The probit link function is: $f(x) = \Phi^{-1}(x)$, where Φ^{-1} is the inverse of the standard normal cumulative distribution function (IBM Corporation, 2011b).

The generalized linear model in SPSS was used to conduct the analyses. Separate probit analyses were conducted to evaluate each research question. The binomial distribution was specified, and the “events” were the number of students passing each test, while the “trials” were the total number of students (campus size). Depending on the particular research question being analyzed, either the Reading or Mathematics number of students passing divided by the total number of students was used as the response variable. The focus areas of technology integration were used as separate independent variables, entered into the model as factors such that differences between the levels of integration could be explicitly examined.

Because multiple individual tests were conducted to evaluate the hypotheses, this raises the likelihood of overall type I error in the study. Accordingly, the Šídák correction was used to correct for the familywise alpha level in the analysis of the six individual hypotheses. The formula for this correction is $1-(1-\alpha)^{1/n}$, where n is the number of independent tests and α is the desired overall level of significance (Abdi, 2007). With six independent tests and an overall α level of .05, this equates to an individual α level of $(1 - (.95)^{.1667})$, or α = .009.

Pairwise comparisons were made between the estimated marginal means for each level of integration. For example, the marginal mean of the proportion of students passing for campuses reporting EarlyTech level of integration was compared to the mean for campuses reporting Developing Tech and so on. For the pairwise comparison of means within each hypothesis, the sequential Šídák correction to the alpha level was used (often called the Holm-Šídák test), as this is a more powerful alternative to the standard Šídák method. This sequentially rejective procedure is much less conservative in terms of rejecting individual hypotheses but maintains the same overall significance level. The sequential method uses a series of steps in the correction depending on the result of each prior step. Contrasts are ordered according to their p-values, from smallest to largest, and each step corrects for the previous number of tests rather than all the tests in the set (IBM Corporation, 2011).

Two multiple probit analyses were also conducted on the Reading and Mathematics scores to determine the unique contribution of each focus area of integration on the proportion of students passing the achievement tests. Thus in the first analysis, the number of students (out of total students) passing the Reading achievement test served as the response variable, and all three integration areas served as the independent variables. Only main effects were specified. This can be considered analogous to the multiple linear regression scenario, but with the probit link function rather than the identity function. The analysis was repeated on the Mathematics scores. The goal of these analyses was to determine the unique contribution of the areas of technology integration to the prediction of achievement, over and above that predicted by the other focus areas. This analysis was warranted due to the intercorrelations among the focus areas of technology integration.

SCOPE AND LIMITATIONS

The accuracy of the STaR Chart data is limited to the level of accuracy and standardization of answers from teachers. STaR Chart data is self-reported and the levels of integration are a self-analysis by teachers. The STaR Chart contains descriptors for each level however persons completing the survey may not accurately assess the technology component in each area. Nonetheless, the STaR Chart is the only statewide assessment of technology integration in the state of Texas. The Texas Education Agency (TEA) requires campuses and districts to complete and submit the data in order to be eligible for technology grant programs and uses the data to evaluate the technology application in schools for the state.

This study was limited to middle school campuses in Texas serving students in grades six through eight. Another limitation was that this study was restricted to the achievement in two core subject areas: Reading and Mathematics. While technology integration obviously can affect other subject areas, Reading and Mathematics were the only subject areas tested in every sixth through eighth grade level.

A final limitation of this study was that a variety of other factors can effect student achievement and technology integration. Administrative support is also necessary for technology integration, not only in providing professional development, but monitoring for implementation. Teacher competency in using technology could also affect the level of technology integration. Finally, student background knowledge, socio-economic status, attitudes toward technology, gender, and ethnicity also affect the achievement of students. While all these elements are factors to effectively integrate technology in teaching and learning, the end result can be measured by what the teacher does in the classroom.

CHAPTER 4
Results

This study examined the research problem: What is the relationship between the degree to which schools have integrated technology into teaching and learning and student achievement? Each of the six research questions involved one independent variable and one dependent variable:

1. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores?

2. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores?

3. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores?

4. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores?

5. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores?

6. Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores?

The probit analysis using the generalized linear model was used as the statistical method for data analysis in this study. Using the techniques described in Chapter 3, the study analyzed whether a difference existed in math and reading scores on the TAKS assessment and the level of technology integration on campuses. Schools in this study were Texas middle schools that included grades six, seven, and eight. As the dependent variable, the overall percentage of sixth through eighth grade students passing the state-mandated achievement tests were selected since technology integration affects an entire campus.

The study sample consisted of data obtained from 1,106 Texas middle schools from the 2010-2011 school year. The data were obtained from the Texas Education Agency (TEA) website. The independent variables were the campus level STaR Chart ratings in the three focus areas of Patterns of Classroom Use (TL1), Frequency/Design of Instructional Setting Using Digital Content (TL2), and Content Area Connections (TL3). The dependent variables were obtained from the percentage of students on a campus passing the TAKS Reading and Mathematics assessment in grades six to eight and the campus size.

Specific questions identified included: (1) How does the degree of implementation in the three focus areas relate to student achievement in math?; (2) How does the degree of implementation in the three focus areas relate to student achievement in reading?; and (3) Is there a difference in the achievement of students in reading and math at campuses with target levels of integration in the three focus areas? These questions dealt with whether the level of implementation has an impact on student achievement in Texas middle schools. Six null hypotheses were based on these research questions with an alpha level = 0.009.

H_O^1: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_O^2: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_O^3: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_O^4: There is no statistical difference (α= .009) between levels of technology the integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_O^5: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_O^6: There is no statistical difference (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

DESCRIPTION OF THE INDEPENDENT VARIABLES

The Texas middle school campus-wide ratings regarding levels of technology integration on the STaR Chart in the area of Patterns of Classroom Use (TL1), Frequency/Design of Instruction Setting Using Digital Content (TL2), and Content Area Connections (TL3) are shown in Table 1. The majority of campuses reported as Developing Tech in the category of Patterns of Classroom Use (56%). However, most campuses reported a level of Advanced Tech for the categories of Frequency/Design of Instructional Setting Using Digital Content (62%) and Content Area Connections (72%).

Table 1

STaR Chart Summary for Texas Middle School Campuses - Independent Variables

Teaching and Learning Category	Early Tech	Developing Tech	Advanced Tech	Target Tech
Patterns of Classroom Use (TL1)	2%	56%	41%	1%
Frequency/Design of Instructional Setting Using Digital Content (TL2)	2%	29%	62%	7%
Content Area Connections (TL3)	1%	25%	72%	2%

Correlations between areas of technology integration. As the degree of technology integration is rated on a 4-point ordered scale, the use of Spearman rank correlation coefficients was appropriate to investigate the relationships between the focus areas. The results are shown in Table 2. There were statistically significant correlations between the rating scores in the three areas of technology integration (all p values <

.001). The correlation between Patterns of Classroom Use and Content Area Connections was in the moderate to large range, with a value of ρ = .398 (p < .001). The correlation between Frequency/Design of Instructional Setting and Content Area Connections was larger at ρ =.466 (p < .001), also signifying a moderate to large positive relationship. Finally, the largest correlation was between Patterns of Classroom Use and Frequency/Design of Instructional Setting, with a correlation of ρ = .471 (p < .001).

Table 2

Spearman rank correlation coefficients between the three areas of technology integration

	Patterns of Classroom Use (TL1)	Frequency/Design of Instructional Setting using Digital Content (TL2)	Content Area Connections (TL3)
Patterns of Classroom Use (TL1)	1.000	.471***	.398***
Frequency/Design of Instructional Setting using Digital Content (TL2)	.471***	1.000	.466***
Content Area Connections (TL3)	.398***	.466***	1.000

Note. ***p < 0.001 (2-tailed). N = 1106.

Differences between distributions of ratings in the areas of technology integration. A related-samples Friedman's two-way analysis of variance by ranks was used to compare the distributions of scores in the three areas of technology integration. The purpose of this analysis was to determine whether there were differences in the rating levels between the three focus areas. The statistic was significant, indicating differences between the distributions of scores in two or more of the areas of integration, χ^2 (2, n = 1106) = 431.41, p < .001. The average ranks were 1.67 for Patterns of Classroom Use, 2.15 for Frequency/Design of Instructional Setting, and 2.18 for Content Area Connections. Pairwise comparisons indicated that the average rank for Patterns of Classroom Use was significantly lower than the other two domains (p < .001). The distributions for Frequency/Design of Instructional Setting and Content Area Connections were not significantly different from one another (p = .531).

DESCRIPTION OF THE DEPENDENT VARIABLES

The percentage of students on a campus passing TAKS Reading and Mathematics assessments were obtained from the TEA website for the year 2010-11. The campus size for the 1,106 middle schools was also obtained.

Percentage Passing Scores in Reading and Mathematics. The descriptive statistics for the percentage passing the Reading and Mathematics achievements are shown in Table 3. The mean percentage passing score on the TAKS Reading achievement test was 87.68% (SD = 7.09). The scores ranged from a low of 57% to a high of 99%. The scores were somewhat skewed toward the higher end of the with a median of 89% passing, a 25th percentile of 83%, and a 75th percentile of 93%.

Table 3.

Descriptive statistics for TAKS Reading and Mathematics Percentage Passing Scores

Statistics		Reading (%)	Mathematics (%)
N		1106	1106
Mean		87.68	83.91
SD		7.09	9.29
Minimum		57	33
Maximum		99	99
	25%ile	83	79
Quartiles	50%ile	89	85
	75%ile	93	91

The percentage passing the Mathematics test had an average of 83.91% (SD = 9.29%), and a range of 33% to 99%. The distribution of scores was also somewhat skewed towards the higher end of the spectrum with relatively few low scores under 60%.

Total number of students passing adjusted by campus size. There was significant variability in the campus size of the schools surveyed for this research, as illustrated in Table 4. The smallest campus had 31 students while the largest had 1,816 students. The average campus size was 667.18 (SD = 361.32). Accordingly, the number of students that are represented by each of the "percentage passing" rates also varied considerably. The number of students passing each test was computed by multiplying the campus size by the percentage passing rate, and then rounding the result to the nearest integer. The descriptive statistics for the resultant scores are reported in Table 4, and the distribution histograms are in Figures 2 and 3. The number of students calculated as passing the Reading achievement test ranged between 31 and 1,725 students, with a mean of 587.36 (SD = 331.11). The number of students passing the Mathematics achievement test ranged between 25 and 1,664 students, with a mean of 564.12 (SD = 322.18).

Table 4

Descriptive statistics for campus size, and numbers of students passing TAKS Reading and Mathematics assessment

			Number of Students Passing[a]	
Statistics		Campus Size	Reading	Mathematics
N		1106	1106	1106
Mean		667.18	587.36	564.12
SD		361.32	331.11	322.18
Minimum		31	31	25
Maximum		1816	1725	1664
	25%ile	369.00	311.75	292.50
Quartiles	50%ile	687.50	583.50	569.00
	75%ile	912.00	804.75	782.00

Note. [a]Number of students passing obtained by multiplying the percentage passing by the campus size, and then rounding to the nearest integer.

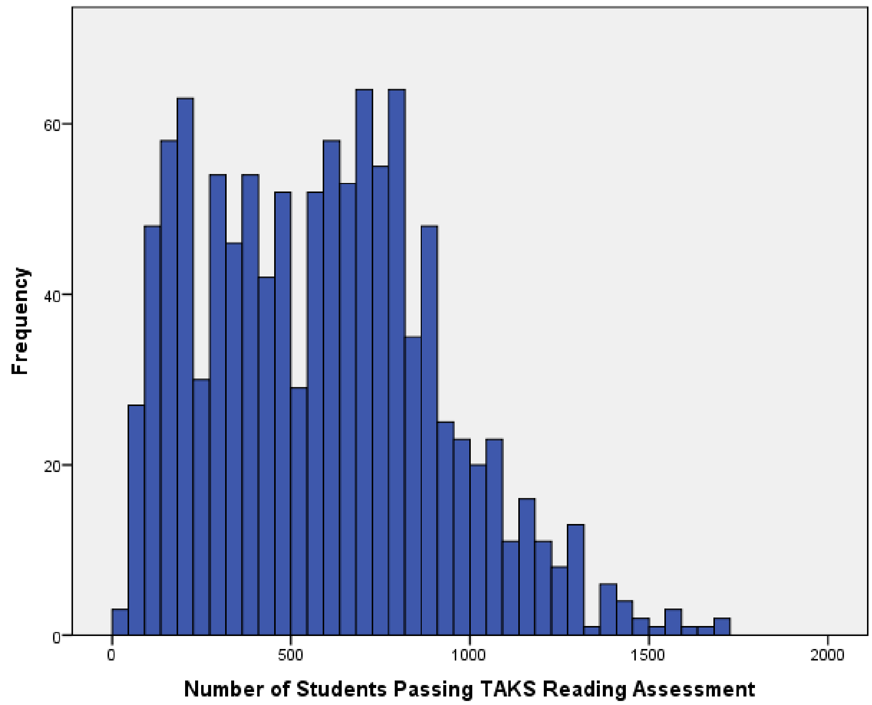

Figure 2. Distribution histogram for number of students passing TAKS Reading assessment (calculated from percentage passing and campus size)

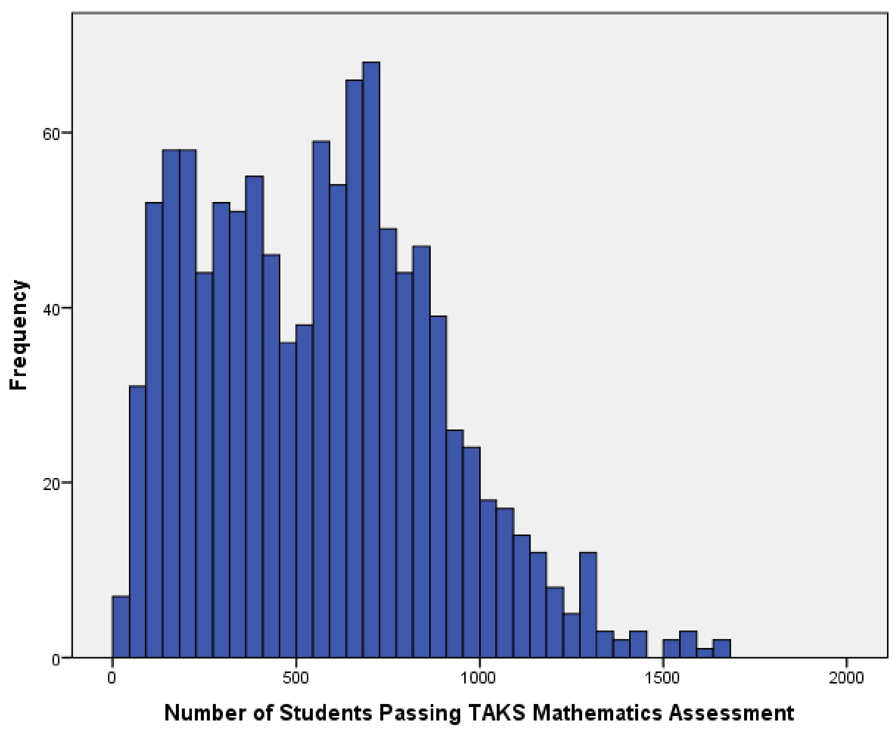

Figure 3. Distribution histogram for number of students passing TAKS Mathematics assessment (calculated from percentage passing and campus size)

Correlations between Reading and Mathematics achievement. The Pearson correlation coefficient between the Reading and Mathematics scores were calculated to determine the degree of relationship between these two areas of achievement. The correlation coefficient was very high between the percentage passing rates on the two tests, at $r = .851$ ($p < .001$), indicating significant overlapping variance between these two scores. For the absolute number of students passing calculated from the campus size, the correlation between Reading and Mathematics was extremely high ($r = .995$, $p < .001$).

Differences between Reading and Mathematics achievement. The mean scores for Reading and Mathematics were compared using paired-samples t tests to determine whether the percentage or number of students passing differed in the two achievement areas. In terms of percentage passing, the mean for Reading (87.68%) was significantly higher than the mean passing score for Mathematics (83.91%), $t(1105) = 25.35$, $p < .001$. For the total number of students passing each test, again the average number of students passing the Reading test (587.36) was significantly higher than the average number of students passing the Mathematics test (564.12), $t(1105) = 22.70$, $p < .001$.

METHODOLOGY

As described previously, absolute counts were created for the dependent variables by multiplying the percentage passing rates for Reading and Mathematics scores by the total campus size. For example, a Reading percent passing rate of 60% for a campus size of 200 would yield a value of 120 students passing. Then, these values were rounded to the nearest integer, and these served as the number of “events” (i.e., instances of passed achievement tests) in the number of “trials” (i.e., the total campus size).

The generalized linear model was used for the analyses. The binary probit link function was specified. This was used rather than the logit model, since it can be assumed that the pass/fail outcome is an artificial dichotomization of an actual underlying score on the achievement test, which would follow a normal distribution. In other words, students achieving a certain score or below are marked as "failing" while students achieving a certain score or above are marked as "passing," but in actuality the score range is much larger than this dichotomous outcome.

The predictors were the categories of technology integration, entered as factors. The analyses were first conducted on each of the dependent variables with each of the independent variables separately, to address the six hypotheses of this study. Multiple probit analyses were then conducted on each dependent variable with the three independent variables entered simultaneously. This was to determine what the unique relationships were between the focus areas and the achievement scores.

A Pearson chi-square scaling parameter method was used to correct for overdispersion in each analysis. The Wald chi-square statistics and confidence intervals were used to assess the parameters. Pairwise comparisons were conducted between each of the levels of the independent variables, with the sequential Šídák adjustment to the alpha level for multiple comparisons.

ANALYSIS OF RESEARCH QUESTION 1

H_0^1: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_a^{1}: There is a statistically significant relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores.

The probit analysis was conducted using the generalized linear model, with the response variable being the number of students passing the Reading achievement test out of the total campus size. The result showed an overall effect of the Patterns of Classroom Use on the proportion of students passing the TAKS Reading achievement test, Likelihood Ratio $\chi^2(3) = 60.102$, $p < .001$. The estimated marginal means and results of the pair-wise comparisons are shown in Figure 4. There was a trend for higher proportions of students passing the test with each subsequent level of integration. However, due to the large standard errors in the Early Tech and Target Tech groups (due to very small sample sizes in those groups) not all of these differences were statistically significant. Using a sequential (step-down) Šídák adjustment for multiple comparisons and an overall p-value of .05, the marginal means for Early Tech (85.55) and Developing Tech (86.71) were not significantly different from one another. However, these were both significantly lower than the mean for Advanced Tech (89.87). The mean for the Target Tech (90.18) group did not differ from any of the other scores, due to the large standard error.

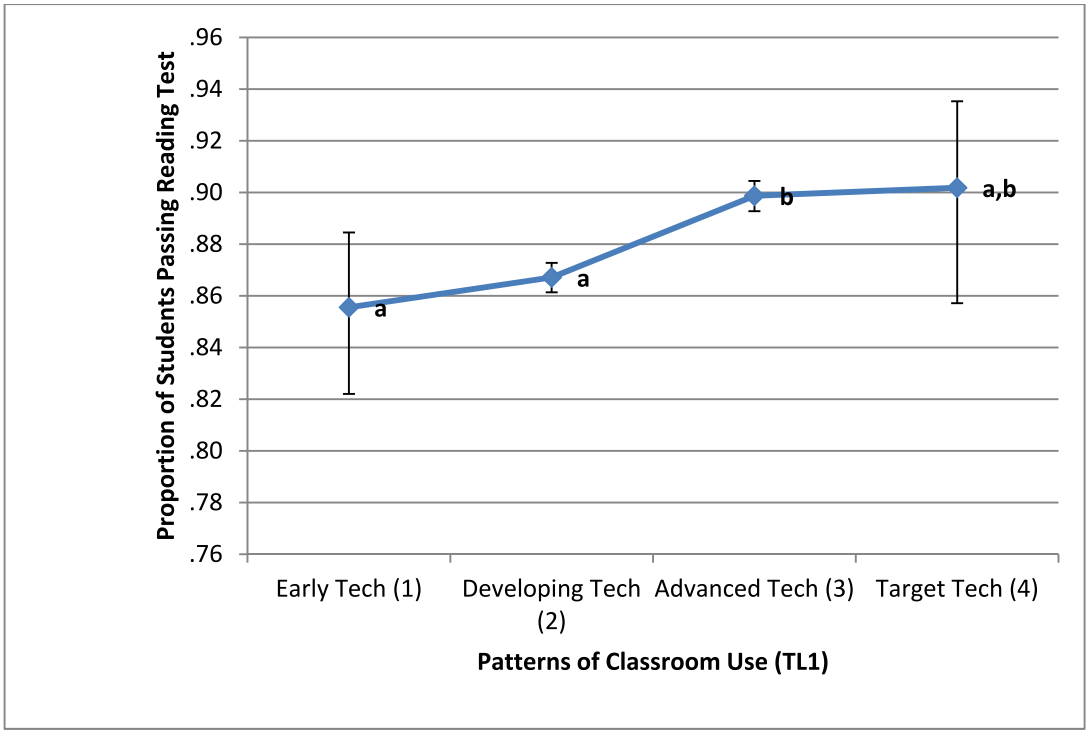

Figure 4. Estimated marginal means for proportions of students passing the TAKS Reading test according to the levels of integration of the STaR Chart, Patterns of Classroom Use (TL1). The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak adjustment) are identified using subscript letters.

In summary, the hypothesis associated with research question 1 was supported. There was a significant relationship between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores. The means showed a trend for increasing proportions of students passing the Reading achievement test, with each successive increase in the level of technology integration. Using formal statistical criteria, the mean passing proportions for Early Tech and Developing Tech were significantly lower than for Advanced Tech.

ANALYSIS OF RESEARCH QUESTION 2

H_0^2: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_a^2: There is a statistically significant relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores.

The results of the probit analysis showed an overall effect of the levels of technology integration in the focus area of Frequency/Design of Instructional Setting Using Digital Content, on the proportion of students passing the TAKS Reading achievement test, Likelihood Ratio $\chi^2(3) = 31.527$, $p < .001$. The marginal means for the proportion of students passing the Reading achievement test are shown in Figure 5. The means showed an increasing trend with each subsequent increase in the level of technology integration. The mean proportion passing for Early Tech was 84.27, for Developing Tech the mean was 86.54, for Advanced Tech the mean was 88.62, and for Target Tech the mean was 90.19. The confidence interval based on the standard error was particularly large for Early Tech. Pairwise comparison using the sequential Šídák adjustment to the alpha level showed that the mean for Early Tech was significantly lower than Target Tech. The mean for Developing Tech was lower than both Advanced Tech and Target Tech.

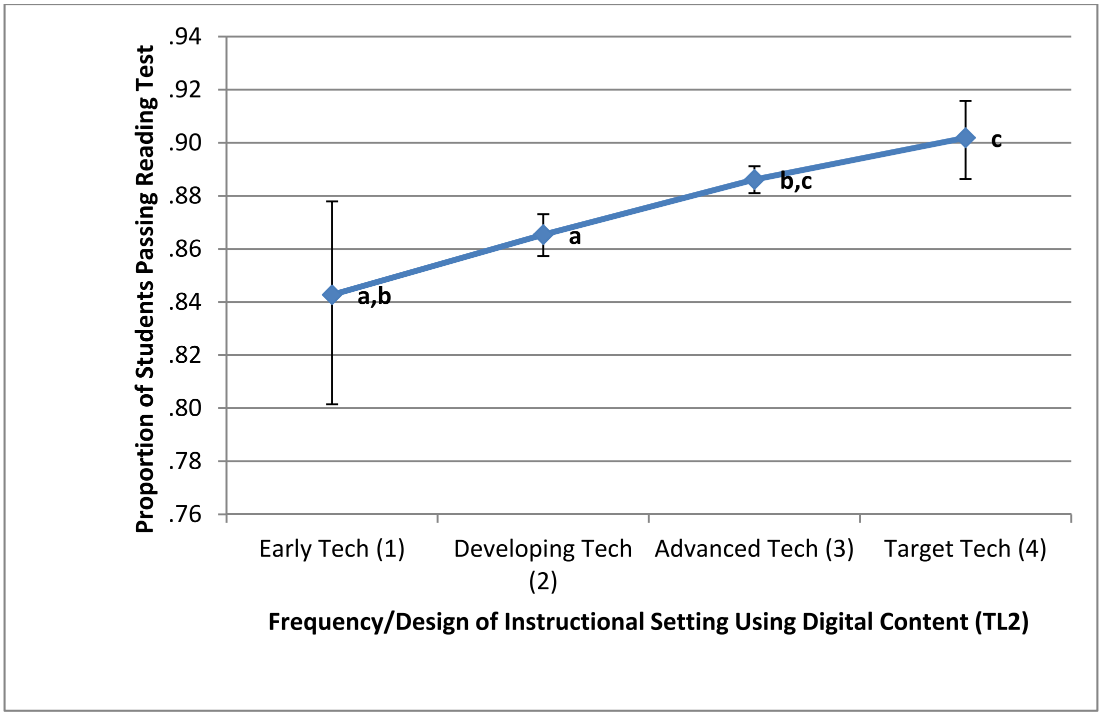

Figure 5. Estimated marginal means for proportions of students passing the TAKS Reading test according to the levels of integration of the STaR Chart, Frequency/Design of Instructional Setting Using Digital Content (TL2). The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters.

In summary, the hypothesis for research question 2 was supported. There was a significant relationship between the levels of integration on the STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as assessed by grades six through eight TAKS scores. This was reflected in the differences in the estimated mean proportions of students passing the test according to the levels of technology integration. The means increased as the level of technology integration increased. Statistical analysis showed that the mean for Early Tech was significantly lower than the mean for Target Tech, and the mean for Developing Tech was significantly lower than Advanced Tech and Target Tech.

ANALYSIS OF RESEARCH QUESTION 3

H_o^3: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores.

H_a^3: There is a statistically significant relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores.

The probit analysis showed a significant relationship between the levels of technology integration in Content Area Connections and the proportion of students passing the Reading achievement test, Likelihood Ratio χ^2 (3) = 36.317, $p < .001$.

The mean proportions passing the Reading test for each level of technology integration are shown in Figure 6. The means increased between Early Tech, Developing Tech, and Advanced Tech, and then decreased slightly for Target Tech. However, the confidence intervals were very large for Early Tech and Target Tech due to the small sample sizes in these groups. Pairwise comparisons showed that the means for Early Tech (80.77) and Target Tech (87.86) did not differ from the other mean scores due to this. However, the mean for Developing Tech (85.96) was significantly lower than the mean for Advanced Tech (88.75).

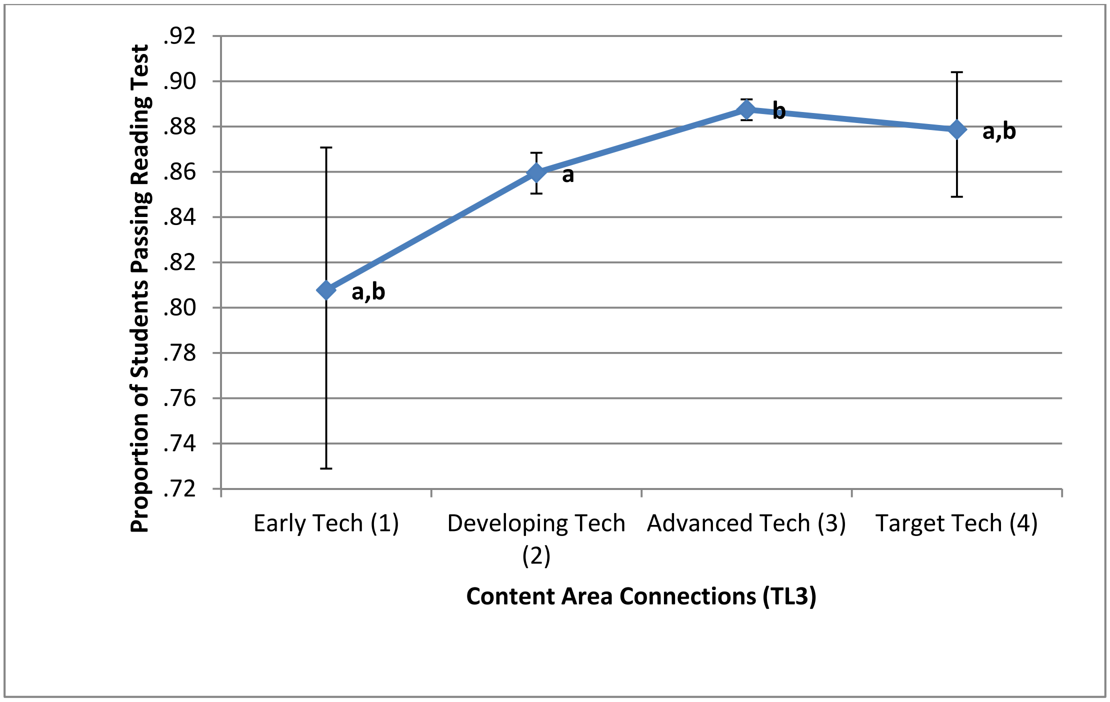

Figure 6. Estimated marginal means for proportions of students passing the TAKS Reading test according to the levels of integration of the STaR Chart, Content Area Connections (TL3). The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters.

Therefore, the alternative hypothesis associated with research question was supported. There was a significant overall relationship between the levels of technology integration on the STaR Chart, Content Area Connections, and student achievement on the TAKS Reading test in grades six through eight. The mean proportion of students passing the Reading test showed a trend of generally increasing rates with higher levels of technology integration. Statistically, Developing Tech was significantly lower than Advanced Tech.

EVALUATION OF THREE ASPECTS OF TECHNOLOGY INTEGRATION ON READING SCORES

As shown in previous sections, there were moderate, positive intercorrelations between the three aspects of technology integration. Schools that reported a higher degree of implementation in one area of technology integration tended to also report higher implementation in the other areas of technology integration. In a regression context, the intercorrelations between the aspects of technology integration mean that their unique contribution to the prediction of Reading achievement may not be analogous to their total contribution. As such, multiple probit regression analysis was used to determine the relative contribution of each of the aspects of technology integration to Reading scores, over and above that accounted for by the other predictors.

The details of the model specifications remained unchanged from the analyses of the individual focus areas as reported above. However, in the multiple analyses, all three focus areas of integration were entered as factors. The model was specified to include the main effects of the three factors (plus the intercept). The omnibus test showed that the model was significantly predictive of the proportion of students passing the Reading test, Likelihood Ratio χ^2 (9) = 78.291, $p < .001$. The Wald Chi-square model effects for each focus area are shown in Table 4. It can be seen that Patterns of Classroom Use ($p < .001$) and Content Area Connections ($p = .010$) were statistically significant predictors of the proportion of students passing the Reading test. However, Frequency/Design of Instructional Setting using Digital Content was not a significant predictor ($p = .223$). Therefore, this focus area did not contribute unique variance to the prediction of Reading achievement, over and above that accounted for by the other two aspects of technology integration.

Table 5

Tests of Model Effects for Multiple Probit Analysis of three areas of technology integration on Proportion of Students Passing the Reading Achievement Test

Source	Type III		
	Wald Chi-Square	df	Sig.
(Intercept)	547.642	1	.000
Patterns of Classroom Use (TL1)	26.390	3	.000
Frequency/Design of Instructional Setting (TL2)	4.387	3	.223
Content Area Connections (TL3)	11.246	3	.010

Events: Reading - Number of Students Passing
Trials: Campus Size
Model: (Intercept), TL1, TL2, TL3

The estimated marginal means from the multiple probit analysis of the proportion of students passing the Reading test for all three focus areas are shown in the chart in Figure 7. The pairwise comparison results (sequential Šídák adjustment) showed that for Patterns of Classroom Use (TL1), the mean for Developing Tech (85.03) was significantly lower than the marginal mean for Advanced Tech (87.73). There were no significant differences between the marginal means for TL2 or TL3. However, there was a marginally significant difference for Content Area Connections (TL3) between the Developing Tech mean (87.45) and the Advanced Tech mean (88.86).

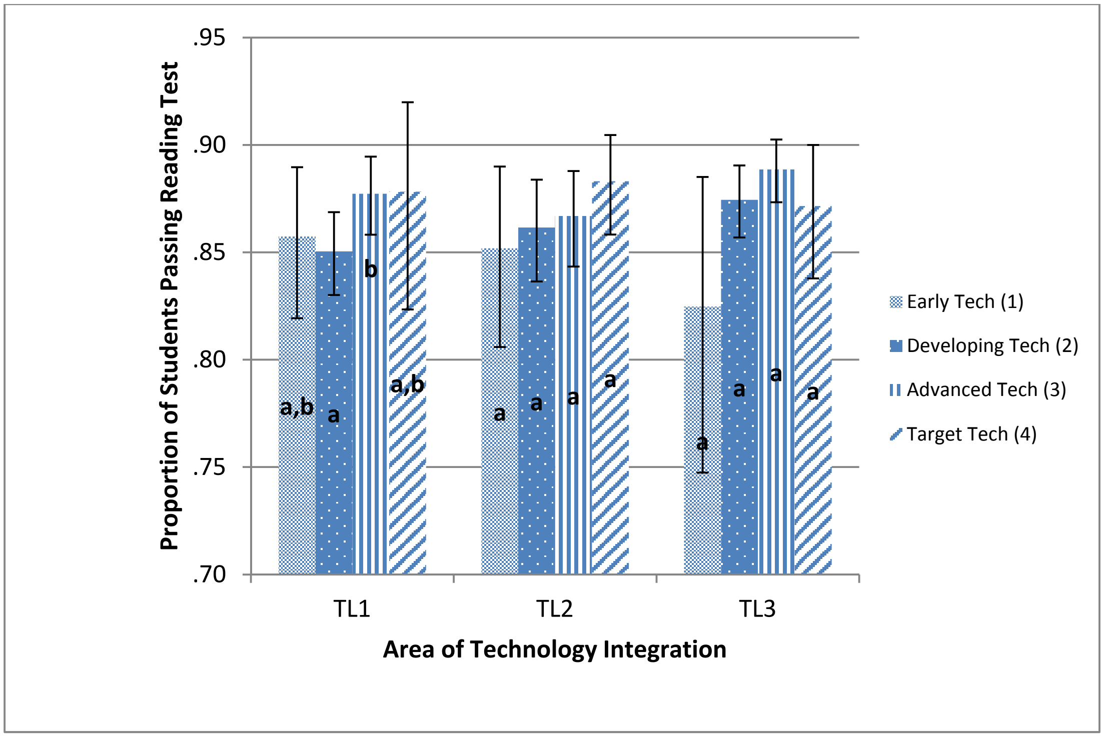

Figure 7. Estimated marginal means from multiple probit analyses, for proportions of students passing the TAKS Reading test according to the levels of integration of the STaR Chart in the three focus areas. The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters (separately for each focus area).

In summary, when all three focus areas of technology integration were considered simultaneously, Patterns of Classroom Use (TL1) emerged as an important, unique predictor of the proportion of students passing the Reading achievement test. Schools reporting Developing Tech in this area had significantly lower proportions of students passing than those reporting Advanced Tech levels of integration. The Frequency/Design of Instructional Setting Using Digital Content (TL2) did not uniquely predict Reading achievement scores over and above that predicted by TL1 and TL3. The Content Area Connections (TL3) focus area also contributed unique variance overall to the prediction of the proportion of students passing the Reading test, although none of the pairwise comparisons reached conventional levels of statistical significance.

ANALYSIS OF RESEARCH QUESTION 4

H_0^4: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_a^4: There is no statistical difference (α= .05) between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grade six through eight TAKS scores.

The probit analysis showed an overall effect of the levels of technology integration in the area of Patterns of Classroom Use, on the proportion of students passing the TAKS Mathematics achievement test, Likelihood Ratio $\chi^2(3) = 71.597$, $p < .001$. The estimated marginal means are shown in Figure 8. A pattern of increasing means of proportion of students passing was seen with respect to increasing levels of technology integration. The mean proportion passing for the Early Tech group was 81.42, for Developing Tech the mean was 82.73, for Advanced Tech the mean was 87.08, and for Target Tech the mean was 87.41. Pairwise comparisons showed that the mean for Advanced Tech was significantly larger than the means for Early Tech or Developing Tech. Target Tech did not differ from the other means due to its large confidence interval.

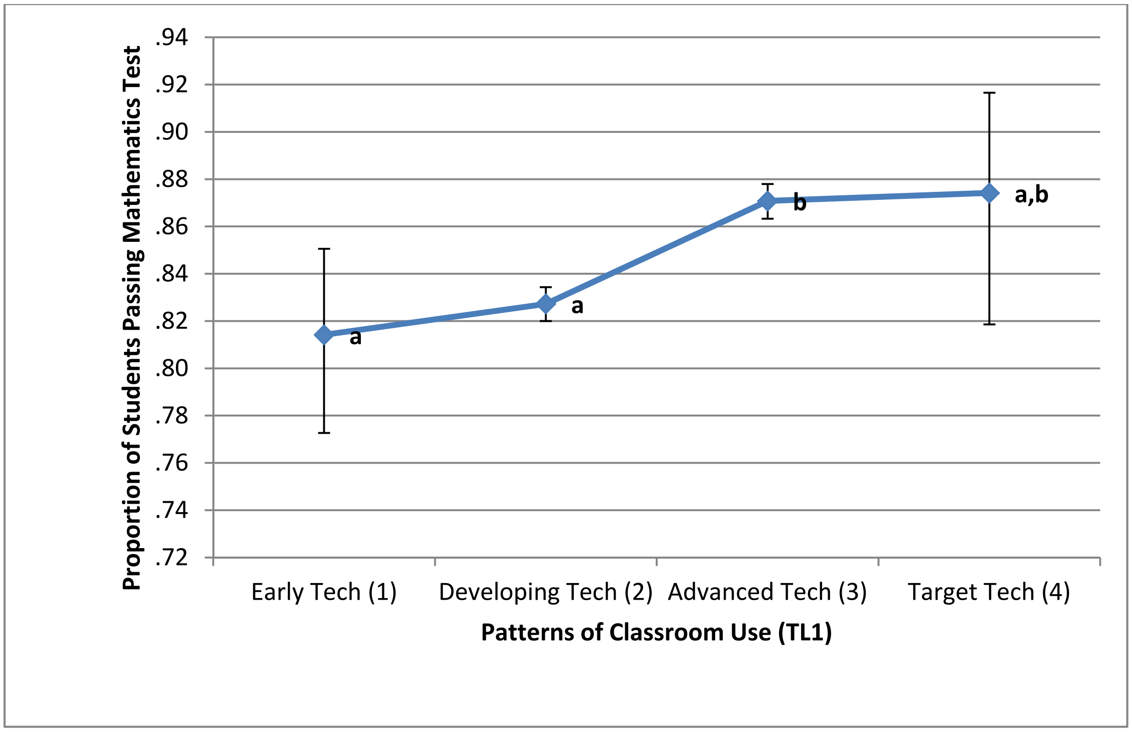

Figure 8. Estimated marginal means for proportions of students passing the TAKS Mathematics test according to the levels of integration of the STaR Chart, Patterns of Classroom Use (TL1) The 95% Wald confidence interval is shown. Significantly different means at p < .05 (using sequential Sidak approach) are identified using subscript letters

In summary, the hypothesis associated with research question 4 was supported. The levels of technology integration on the STaR Chart, Patterns of Classroom Use, differed in terms of Mathematics achievement for grades six through eight. The data showed a trend towards increasing mean proportions of students passing the Mathematics test with the successive increases in the level of integration. The mean for the Advanced Tech group was significantly higher than for Early Tech or Developing Tech.

ANALYSIS OF RESEARCH QUESTION 5

H_0^5: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional

Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_a^5: There is a statistically significant relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

The results of the probit analysis showed an overall effect of the levels of technology integration with regard to the Frequency/Design of Instructional Setting Using Digital Content, on the proportion of students passing the TAKS Mathematics achievement test, Likelihood Ratio $\chi^2(3) = 34.388$, $p < .001$. The means for the proportion of students passing the Mathematics achievement test are shown in Figure 9. The marginal means showed an increasing trend with each subsequent increase in the level of technology integration. The mean proportion passing for Early Tech was 78.19, for Developing Tech the mean was 82.57, for Advanced Tech the mean was 85.48, and for Target Tech the mean was 86.16. The confidence interval based on the standard error was particularly large for Early Tech, and to a lesser extent for Target Tech. Pairwise comparison using the sequential Šídák adjustment to the alpha level showed that the means for Early Tech and Developing Tech were significantly lower than the means for Advanced Tech or Target Tech.

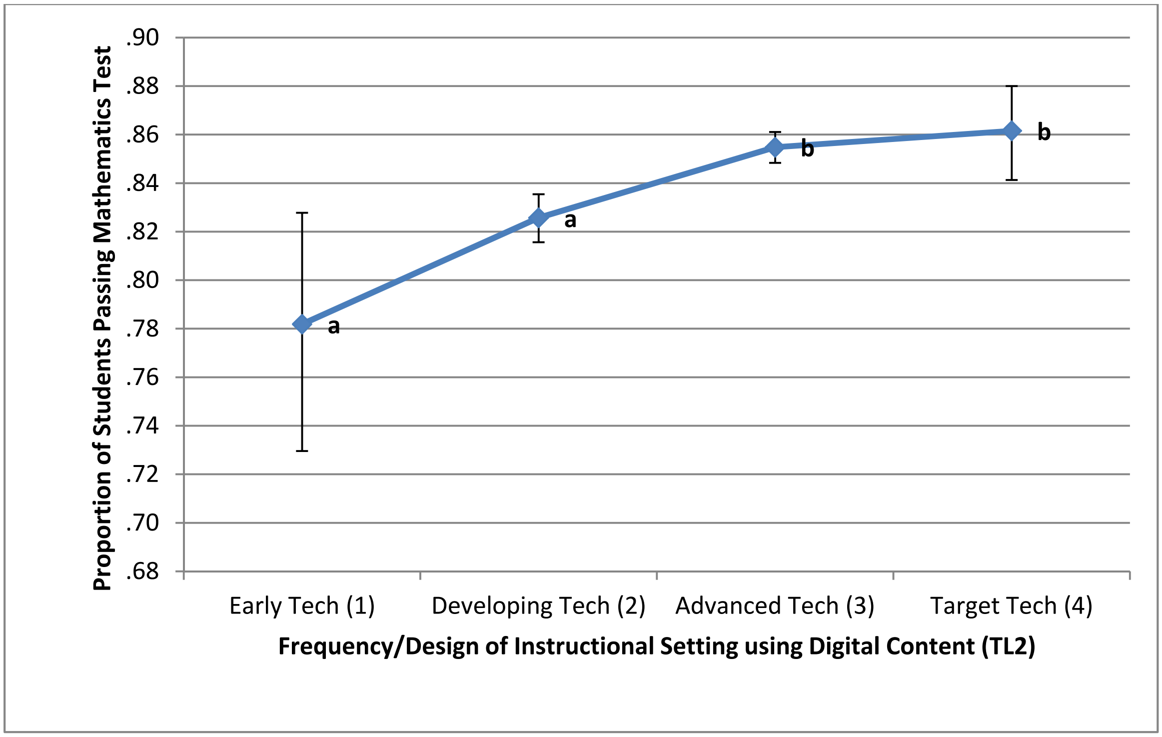

Figure 9. Estimated marginal means for proportions of students passing the TAKS Mathematics test according to the levels of integration of the STaR Chart, Frequency/Design of Instructional Setting Using Digitial Content (TL2). The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters.

In summary, the hypothesis associated with research question 5 was supported. There was a significant relationship between the levels of integration on the STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as assessed by grades six through eight TAKS scores. This was reflected in the differences in the mean proportions of students passing the test according to the levels of technology integration. The means showed an increasing trend as the level of technology integration increased. Statistical analysis showed that the means for Early Tech and Developing Tech were significantly lower than the means for either Advanced Tech or Target Tech.

ANALYSIS OF RESEARCH QUESTION 6

H_0^6: There is no statistical relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores.

H_a^6: There is a statistically significant relationship (α= .009) between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grade six through eight TAKS scores.

The probit analysis showed a significant overall relationship between the levels of technology integration in Content Area Connections and the proportion of students passing the Mathematics achievement test, Likelihood Ratio χ^2 (3) = 50.148, $p < .001$.

The mean proportions passing the Mathematics test for each level of technology integration are shown in Figure 10. The means showed an increased pattern between Early Tech, Developing Tech, and Advanced Tech, and then decreased slightly for Target Tech. However, the confidence intervals were very large for Early Tech in particular, and also for Target Tech due to the small sample sizes in these groups. Pairwise comparisons showed that the mean for Early Tech (69.42) was significantly lower than the means in the other groups. The mean for Developing Tech (81.87) was lower than the mean for Advanced Tech (85.57). The mean for Target Tech (82.39) only differed from Early Tech.

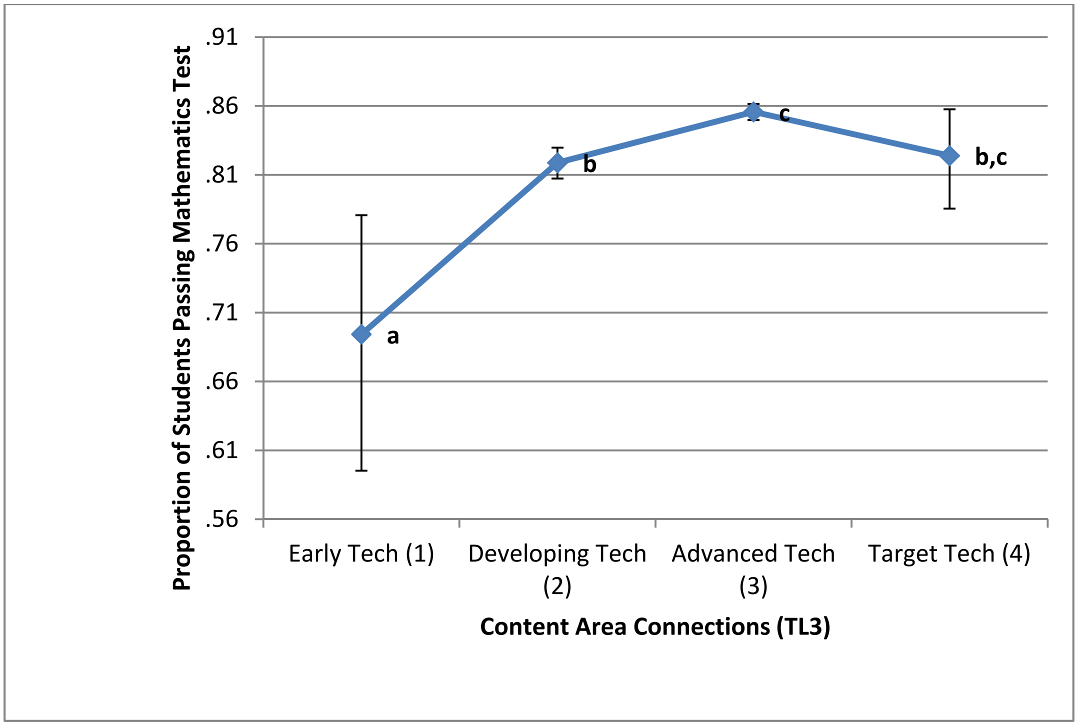

Figure 10. Estimated marginal means for proportions of students passing the TAKS Mathematics test according to the levels of integration of the STaR Chart, Content Area Connections (TL3). The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters.

Therefore, the alternative hypothesis associated with research question 6 was supported. There was a significant overall relationship between the levels of technology integration on the STaR Chart, Content Area Connections, and student achievement on the TAKS Mathematics test for students in grades six through eight. This was reflected in differences in the mean proportion of students passing the test according to the levels of technology integration. The mean in the Early Tech group was significantly lower than the other levels. Developing Tech was significantly lower than Advanced Tech.

EVALUATION OF THREE ASPECTS OF TECHNOLOGY INTEGRATION ON MATHEMATICS SCORES

As with the Reading scores, multiple probit regression analysis was used to determine the relative contribution of each of the aspects of technology integration to Mathematics scores, over and above that accounted for by the other predictors.

The multiple probit model was specified to include the main effects of the three factors (plus the intercept). The proportion of student passing the Mathematics achievement test was the dependent variable.

The omnibus test showed that the model including the three focus areas of technology integration was significantly predictive of the proportion of students passing the Mathematics test, Likelihood Ratio χ^2 (9) = 100.348, $p < .001$. The Wald Chi-square model effects for each focus area are shown in Table 6. It can be seen that Patterns of Classroom Use ($p < .001$) and Content Area Connections ($p < .001$) were statistically significant predictors of the proportion of students passing the Mathematics test. However, Frequency/Design of Instructional Setting using Digital Content was not a significant predictor ($p = .345$). Therefore, this focus area did not contribute unique variance to the prediction of Mathematics achievement over and above that accounted for by the other two aspects of technology integration.

Table 6

Tests of Model Effects for Multiple Probit Analysis of three areas of technology integration on Proportion of Students Passing the Mathematics Achievement Test

Source	Type III		
	Wald Chi-Square	df	Sig.
(Intercept)	330.052	1	.000
Patterns of Classroom Use (TL1)	34.053	3	.000
Frequency/Design of Instructional Setting (TL2)	3.322	3	.345
Content Area Connections (TL3)	20.143	3	.000

Events: Mathematics - Number of Students Passing
Trials: Campus Size
Model: (Intercept), TL1, TL2, TL3

The estimated marginal means from the multiple probit analysis, of the proportion of students passing the Mathematics test for all three focus areas are shown in the chart in Figure 11. The pairwise comparisons (sequential Šídák adjustment) showed that for Patterns of Classroom Use (TL1), the mean for Developing Tech (78.42) was significantly lower than the marginal mean for Advanced Tech (82.44). The means for Early Tech and Target Tech did not differ from the other levels due to their large confidence intervals.

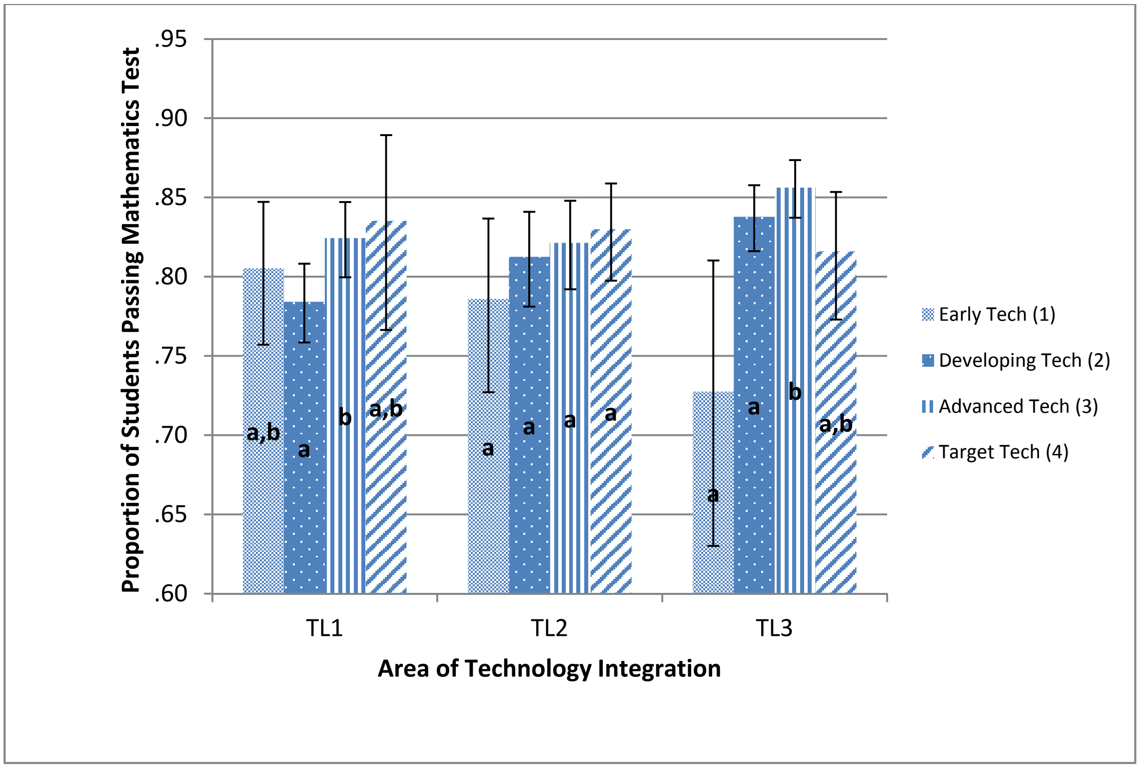

Figure 11. Estimated marginal means from multiple probit analysis, for the proportions of students passing the TAKS Mathematics test according to the levels of integration of the STaR Chart in the three focus areas. The 95% Wald confidence interval is shown. Significantly different means at $p < .05$ (using sequential Sidak approach) are identified using subscript letters (separately for each focus area).

For Frequency/Design of Instructional Setting Using Digital Content (TL2), there were no significant differences between the marginal means. In the area of Content Area Connections (TL3), the marginal mean for Advanced Tech (85.62) was significantly higher than the mean for either Early Tech (72.75) or Developing Tech (83.78). The mean for Target Tech did not differ from the means for the other levels.

In summary, when all three focus areas of technology integration were considered simultaneously, Patterns of Classroom Use (TL1) and Content Area Connections (TL3) emerged as unique predictors of the proportion of students passing the Mathematics achievement test. For both areas, the proportion of students passing in the Developing

Tech level was significantly lower than the Advanced Tech group. In TL3, the Early Tech group was also significantly lower than the Advanced Tech group. The Frequency/Design of Instructional Setting Using Digital Content (TL2) did not uniquely predict Mathematics achievement scores. There were no significant pairwise differences in the levels of this focus area.

SUMMARY

The goal of this study was to examine the relationship between the degree to which schools had integrated technology in three focus areas and student achievement in reading and mathematics. The number of students passing the achievement tests out of the total number of students within each campus was analyzed using the generalized linear model with the probit link function.

The descriptive showed that for each focus area, there were relatively few schools reporting the lowest level of integration of Early Tech (level 1), or the highest level of integration of Target Tech (level 4). Most campuses reported either Developing Tech (level 2) or Advanced Tech (level 3) in each area of technology integration. However, Patterns of Classroom Use (TL1) had a lower overall level of integration than the other two focus areas. There were moderately large correlations between the campus ratings in all three focus areas.

The percentages of students passing the Reading and Mathematics assessments were skewed towards the higher end of the percentage ranges and there were few instances of schools with passing rates lower than about 60%. The number of students per campus varied between 31 and 1,816 students, with the numbers of students passing each test varying accordingly. There were very high intercorrelations between the proportions of students passing the Reading and the Mathematics tests; although, on average, more students passed the Reading test than the Mathematics assessment.

Analysis of the research questions showed that the proportions of students passing the Reading and the Mathematics tests differed according to each area of technology integration. Each of the six alternative hypotheses was supported. In general, as the level of technology integration increased, so did the mean proportion of students passing the tests. Because of the small sample sizes in the areas of Early Tech and Target Tech, there were large standard errors in the estimation of mean proportions of students passing the achievement tests in these groups. Thus, statistically significant differences were often only observed between Developing Tech and Advanced Tech, with the former having significantly fewer proportions of students passing than the latter.

Multiple probit regression analyses of the three target areas on the Reading and Mathematics scores showed that Patterns of Classroom Use (TL1) and Content Area Connections (TL3) were each significantly uniquely predictive of achievement results. However, Frequency/Design of Instructional Setting Using Digital Content (TL2) was not uniquely predictive of achievement over and above that predicted by the other areas of technology integration.

The results were very similar regardless of whether Reading or Mathematics achievement tests were used as the dependent variable. There was a very high intercorrelation between these assessment results. Thus, it could be surmised that the results regarding technology integration were predictive of achievement generally and not specifically Reading nor Mathematics achievement.

CHAPTER 5
Conclusions and Implications

The problem for this study is that while there are significant investments in technology in education, there is little evidence to support the impact of technology integration in teaching with student performance on high-stakes testing. While research exists on both sides of the technology issue, few research studies had been conducted which identify the level of technology integration with regards to frequency of use, teaching pedagogy, and content area connections. The level of engagement needed to accomplish America's education goals requires the use of technology environments and resources (US Department of Education, 2010). Title II, Part D of NCLB, also known as "Enhancing Education through Technology", outlines goals to improve student academic achievement through the use of technology, to ensure that students are technologically literate by the end of grade 8, and to establish effective technology-integrated instructional methods (Learning Point Associates, 2007). In 2009 alone, $269 million was budgeted for state educational technology grants with an additional $650 million allocated in the American Recovery and Reinvestment Act of 2009 (US Department of Education, Enhancing Education Through Technology (Ed-TECH) State Program). Policy makers need to know if the investment in technology has produced positive results.

OVERVIEW OF STUDY

Technology integration into teaching and learning can be studied using the focus areas of patterns of classroom use, frequency/design of instructional setting using digital content, and content area connections (Texas Education Agency, 2006c). These three focus areas identify the level to which teachers and students integrate technology components into teaching and learning. The problem statement for the present study was based on these focus areas in order to determine whether there was a difference between the levels of technology integration and the corresponding student achievement in Reading and Mathematics.

Methodology. The instrument for measuring student achievement was percentages of students passing the standardized TAKS tests. The percentage of students from Texas middle school campuses containing grades six through eight was used as the sample. The three focus areas for technology integration were reflected by the scores on the campus STaR chart. This instrument divides the teaching and learning area into six focus areas, of which three were used for this study. The composition of the questionnaire can be seen in Appendix A.

Data were obtained from the online websites of the Texas Education Agency. Six procedures were used, one for each research question: (1) Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Reading as measured by grades six through eight TAKS scores?; (2)Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Reading as measured by grades six through eight TAKS scores?; (3) Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Reading as measured by grades six through eight TAKS scores?; (4) Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Patterns of Classroom Use, and student achievement in Mathematics as measured by grades six through eight TAKS scores?; (5) Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Frequency/Design of Instructional Setting Using Digital Content, and student achievement in Mathematics as measured by grades six through eight TAKS scores?; and (6) Is there a difference between the levels of technology integration as reported on the Texas STaR Chart, Content Area Connections, and student achievement in Mathematics as measured by grades six through eight TAKS scores? To investigate the six research questions, the generalized linear model with the probit link function was used for binomial distributions.

The dependent variable for questions 1 through 3 was the student performance as measured by the number of students passing the TAKS Reading tests out of the total number of students within each campus. The dependent variable for questions 4 through 6 was the student performance as measured by the number of students passing out of the student population on TAKS Mathematics. The independent variable for questions 1 and 4 was the level of technology integration score on the Patterns of Classroom Use focus area on the campus STaR Chart. The level of technology integration score on Frequency/Design of Instructional Setting Using Digital Content was used as the independent variable for questions 2 and 5. The independent variable for questions 3 and 6 was the level of technology integration score on Content Area Connections.

RESULTS OF THE STUDY

For each research question, results of the probit analyses showed a significant relationship between the levels of technology integration as reported on the Texas STaR Chart and student achievement as measured by percentage of students passing TAKS tests. In general, as the level of technology integration increased, so did the mean proportion of students passing the tests. Because of the small sample sizes in the areas of Early Tech and Target Tech, statistically significant differences were often only observed between Developing Tech and Advanced Tech, with the former having significantly fewer proportions of students passing than the latter.

Multiple probit regression analyses of the three target areas on the Reading and Mathematics scores showed that Patterns of Classroom Use (TL1) and Content Area Connections (TL3) were each significantly uniquely predictive of achievement results. However, Frequency/Design of Instructional Setting Using Digital Content (TL2) was not uniquely predictive of achievement over and above that predicted by the other areas of technology integration.

CONCLUSIONS

This study suggests that in certain applications technology integration does have a significant effect on student achievement. These results support the U.S. Department of Education's (2009) claim that integrating technology into teaching and learning is the primary means by which technology can affect the academic achievement of students. In addition, this research supports the assertions of Funkhouser (2002) and Lin (2006) that student achievement increases when teachers integrate technology into instruction.

Of particular significance is the predictive nature of the independent variables Patterns of Classroom Use and Content Area Connections. These measures indicate whether teachers are using a student-centered environment that is seamlessly integrated with technology and whether the technology is applied across the subject area. This finding supports Roblyer and Doering's (2010) claim that the true impact of technology depends on the method and type of integration.

The significance of the Patterns of Classroom Use variable support the conclusion of Lei and Zhao (2007) that achievement is not impacted by the amount of technology utilized but by the types of tasks assigned to students when using the technology. Creating constructivist events with technology can help increase student knowledge (Becker, 2007). Teachers should strive to apply technology in purposeful and meaningful ways to support learning. Not every learning activity requires technology and technology is not the solution for education. However, digital native students can benefit in terms of academic performance with the appropriate use of digital tools.

The results of the impact of the level of Content Area Connections variable supports research that teachers must have a deep understanding of the complex interaction among content, pedagogy, and technology knowledge in order to effectively utilize technology to address student learning (Niess, 2011; Koehler & Mishra, 2009; Pierson, 2001). The role of the teacher in the application of technology applied to a subject cannot be overlooked. In fact, a technology solution for one content area will not necessarily be the same solution for another subject (Mishra & Koehler, 2006). Teachers must become creative in utilizing technology to promote higher-order learning tasks. Content will determine the types of hardware, software and Web 2.0 tools that are most effective. The curriculum content should serve as the primary focus of instruction with the technology application serving as a secondary focus (Harris & Hofer, 2009).

While this study showed that both achievement in Reading and Mathematics were affected by the levels of technology integration, there was no clear distinction of a benefit to one content over another. The types of technology content solutions for Reading and Mathematics will not necessarily be the same. Reading and writing lends itself to learning with digital content. Databases, computer networks, video, and word processing software provide students with the ability to gather and synthesize information and communicate their knowledge. Students can use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge (Maninger, 2006). Software can be used to assist with reading comprehension, writing, and spelling. Software may also promote creativity in writing through the use of digital storytelling and movie development (Schrum & Levin, 2009). However, students in mathematics have greater need for digital problem solving tools and data collection and display devices such as networked graphing calculators and spreadsheet software.

Implications for School Leaders

Technology integration can help improve student performance, especially if the technology is connected deeply with the content. For this to occur, teachers must understand how to tie together their content knowledge with technology pedagogy. This technology change process will only be successful if the school has an effective leader. The impact of leadership on student achievement has been found to occur indirectly as leadership strengthens the professional learning community (Louis, Leithwood, & Walhstrom, 2010). Administrators must provide the support for technology integration as well as involve the entire educational system to utilize technology towards improving student achievement (Wayman & Stringfield, 2006). The focus should be on sustainable leadership when implementing technology, not on the specific technology that is being implemented.

The NETS for Administrators address five key areas as a framework of best practices in regards to the roles of administrative practice towards technology in education: (1) visionary leadership, (2) digital age learning culture, (3) excellence in professional practice, (4) systemic improvement, and (5) digital citizenship (International Society for Technology in Education, 2009). Part of visionary leadership is to support effective instructional practice with the integration of technology. District and campus administrators should promote professional development in technology integration that is tied directly to content as well as digital tools that can support student-centered learning environments. Action research should be conducted to determine the types of digital tools which are most effective for each content. Administrators should be careful in requiring all staff to participate in digital learning if there is no clear connection to the content or student-centered learning. Hixon and Buckenmeyer (2009) recommended that "it is crucial for technology-related training to be situated in the individual teacher's content" (p 143).

As technology integration becomes integrated with every aspect of society, it is paramount that teachers possess the skills and behaviors of digital age professionals. However, learning about technology is different than learning what to do with it as an instructional methodology (Harris, Mishra, & Koehler, 2009). This is why professional development opportunities should increase the technological pedagogical content knowledge (TPACK) in order to transform teaching practices (Mishra & Koehler, 2006).

The effectiveness of professional development in preparing teachers in the use of technology in the classroom can assist in removing the technology knowledge barrier. As technology integration becomes integrated with every aspect of society, it is paramount that teachers possess the skills and behaviors of digital age professionals. Beyond providing the necessary hardware and infrastructure, establishing professional learning communities (PLC) is a structure that can foster a technological culture. PLCs require learning by doing by providing the tools necessary for teachers to accept technological change (DuFour, DuFour, R., Eaker, & Many, 2006). Sustainable technology leadership can thrive within the structure of PLCs and a cycle of continuous improvement of learning

Beyond vision and planning, school leaders must make staff development and training a priority. Aligning professional development to meet the technology needs of teachers will help to improve instructional performance (Guthrie & Schuermann, 2010). The management element of school leaders includes not only the management of resources but also the monitoring of teacher's use of technology to ensure successful technology integration (Chang, Chin, & Hsu, 2008). Because the integration of technology affects pedagogy and content, professional development should seek to transform professional development to focus on the intersection of all three components (Roblyer & Doering, 2010).

School leaders as well as teachers must be involved in the technology professional development. The support of the school leader comes in not only recognizing a technology-rich lesson, but in being able to provide support and encouragement to teachers when lessons are not well developed (Schrum & Levin, 2009). Change does not happen quickly. Changing teacher's practices in the area of technology integration must focus on pedagogical understandings and connections to curriculum (Crawford, Chamblee, & Rowlett, 1998; Nir & Bogler, 2008; Somech & Bogler, 2002).

IMPLICATIONS FOR FURTHER RESEARCH

The questions of this study investigated if there was a difference in student achievement based on the level of technology integration. Results from the probit analyses showed a statistically significant difference observed between the achievement of Developing Tech and Advanced Tech campuses, particularly in the areas of Patterns of Classroom Use and Content Area Connections. However, the limitations of this study raise some issues for further research.

The STaR Chart data is submitted for an entire campus and is not necessarily representative of the technology integration for a particular content. Training is not required for principals or educators in completing the STaR Chart. Principal knowledge and use of the STaR Chart information are unknown. Although the STaR Chart is a technology planning tool as well as a tool to identify needs for professional development and instructional goals, no research has been conducted to determine how, or even if, campus and district administrators are using this data. With the use of state resources to develop, collect and summarize this data, providing a tool in using the data beyond the state level is needed.

Although teachers complete the Teacher STaR Chart, only campus level data is available from TEA. The teacher data should be made available by TEA in a way that preserves anonymity of the teacher but also allows for results to be summarized by content. Since connections to content are critical in technology integration, this information would allow for deeper research on the impact of a technology on a particular subject. In addition, the STaR Chart is a self-assessment instrument based on the perceptions of the person completing the survey. While indicators for each level are available for teachers to read in evaluating their technology knowledge and usage, no formal communication explaining the indicators is required. Some type of documentation that educators understand the distinctions among the levels is needed. A required video prior to completion of the STaR Chart explaining the levels could help in eliminating some limitations in using the data.

Measures of student perceptions of technology integration could be collected to balance the teacher information. Currently, Texas administers an assessment of technology standards for 8th grade students. However, this instrument only addresses technology standards and not the use of technology in the classroom.

The design of the STaR Chart may not be the best way to measure the integration of technology. As outlined in the literature review of this study, a variety of methods can be employed to integrate technology into a particular content. The diversity of content connections such as software applications and networked calculators lead to an overgeneralization of the impact of these methods. Studies are needed to evaluate the consistency of a method and specific use of technology integration. Knowing "how" teachers are integrating technology would contribute to advancements in learning. In addition, the emergence of Web 2.0 tools and 21st century learning are not considered in the STaR Chart. Research is needed to determine to impact of the methods of communication, collaboration, creativity, and critical thinking on student achievement.

Professional development plays a critical role transforming technology in teaching and learning. Research is needed to determine what types of technology professional development are sufficient to change the level of integration and the corresponding impact on student achievement. Evidence is needed to provide insight into teacher's adoption of technology integration instructional practices emphasized during professional development. Adult learners are intrinsically motivated to learn about solutions to issues that relate directly to their interests. Adults are typically task-centered, experienced, and self-directed (Knowles, 1983). In light of educator training, the most efficient use of a teacher's time in staff development is to participate in training that directly impacts instruction. Improving student achievement or behavior is always the ultimate goal of staff development. Therefore, educators need to be assured that training will have a positive impact on students. While theoretical background knowledge can be helpful in understanding, training that is purely informational in nature and does not bridge to teacher action have little value for educators (Joyce & Showers, 2002). Staff development for teachers is best delivered with a focus on content knowledge and including participation of teachers from the same school, grade or subject (Garet, Porter, Desimone, Birman, & Yoon, 2001).

There are a variety of other factors that can effect student achievement and technology integration. However, it is clear that promoting and providing a digital-age learning environment that is student-centered can impact student achievement. In addition, it is imperative that any attempt to integrate technology into learning must be deliberate and purposeful with clear connections to the curricular learning objectives.

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APPENDIX A

STAR CHART SUMMARY

Texas Campus STaR Chart Summary

9

Using the Texas Campus STaR Chart, select the cell in each category that best describes the campus.
Enter the corresponding number in the chart below using this scale:

1 = Early Tech 2 = Developing Tech 3 = Advanced Tech 4 = Target Tech

Key Area I: Teaching and Learning

TL1 Patterns of Classroom Use	TL2 Frequency/ Design of Instructional Setting	TL3 Content Area Connections	TL4 Technology Applications (TA) TEKS Implementation	TL5 Student Mastery of Technology Applications	TL6 Online Learning	*Total

Key Area II: Educator Preparation and Development

EP1 Professional Development Experiences	EP2 Models of Professional Development	EP3 Capabilities of Educators	EP4 Access to Professional Development	EP5 Levels of Understanding and Patterns of Use	EP6 Professional Development for Online Learning	*Total

Key Area III: Leadership, Administration and Instructional Support

L1 Leadership and Vision	L2 Planning	L3 Instructional Support	L4 Communication and Collaboration	L5 Budget	L6 Leadership and Support for Online Learning	*Total

Key Area IV: Infrastructure for Technology

INF1 Students per Computers	INF2 Internet Access Connectivity Speed	INF3 Other Classroom Technology	INF4 Technical Support	INF5 Local Area Network Wide Area Network	INF6 Distance Learning Capacity	*Total

Key Area Summary

Copy your Key Area totals into the first column below and use the Key Area Rating Range to indicate the Key Area rating for each category.

Key Area — *Key Area Total — Key Area STaR Classification

I. Teaching and Learning ________ ________
(6-8 Early Tech 9-14 Developing Tech 15-20 Advanced Tech 21-24 Target Tech)

II. Educator Preparation and Development ________ ________
(6-8 Early Tech 9- 4 Developing Tech 15-20 Advanced Tech 21-24 Target Tech)

III. Leadership, Administration & Instructional Support ________ ________
(6-8 Early Tech 9-14 Developing Tech 15-20 Advanced Tech 21-24 Target Tech)

IV. Infrastructure for Technology ________ ________
(6-8 Early Tech 9-14 Developing Tech 15-20 Advanced Tech 21-24 Target Tech)

Campus Name: ____________ County/District/Campus Number: ____________

School Year: ____________ Completion Date: ____________

Completed by : ____________ Email: ____________

Please go to the online Texas Campus STaR Chart (www.tea.state.tx.us/starchart) to enter the campus results and print reports.

APPENDIX B

APPROVAL FROM THE UNIVERSITY OF HOUSTON HUMAN SUBJECT RESEARCH COMMITTEE

UNIVERSITY of **HOUSTON**

DIVISION OF RESEARCH

July 5, 2012

Rhonda Wade
c/o Dr. Sara G. McNeil
Curriculum and Instruction

Dear Rhonda Wade,

Based upon your request for exempt status, an administrative review of your research proposal entitled "Educational Leadership: The Impact of Technological Teaching and Learning on Student Achievement in Reading and Mathematics" was conducted on May 23, 2012.

At that time, your request for exemption under **Category 4** was approved pending modification of your proposed procedures/documents.

The changes you have made adequately respond to the identified contingencies. As long as you continue using procedures described in this project, you do not have to reapply for review. * Any modification of this approved protocol will require review and further approval. Please contact me to ascertain the appropriate mechanism.

If you have any questions, please contact Alicia Vargas at (713) 743-9215.

Sincerely yours,

Kirstin Rochford, MPH, CIP, CPIA
Director, Research Compliance

*Approvals for exempt protocols will be valid for 5 years beyond the approval date. Approval for this project will expire **May 1, 2017**. If the project is completed prior to this date, a final report should be filed to close the protocol. If the project will continue after this date, you will need to reapply for approval if you wish to avoid an interruption of your data collection.

Protocol Number: 12482-EX

316 E. Cullen Building Houston, TX 77204-2015 (713) 743-9204 Fax: (713) 743-9577
COMMITTEES FOR THE PROTECTION OF HUMAN SUBJECTS

APPENDIX C

CATEGORIES OF TEACHING AND LEARNING ON THE STAR CHART

The Texas Teacher School Technology and Readiness (STaR) Chart

KEY AREA:	TEACHING & LEARNING					
Focus Area:	TL 1	TL 2	TL 3	TL 4	TL 5	TL 6
Levels of Progress:	**Patterns of Classroom Use**	**Frequency/ Design of Instructional Setting Using Digital Content**	**Content Area Connections**	**Technology Applications (TA) TEKS Implementation** (TAC Chapter 126)	**Student Mastery of Technology Applications (TA) TEKS**	**Online Learning**
Early Tech	I occasionally use technology to supplement instruction, streamline management functions, and present teacher-centered lectures My students use software for skill reinforcement	I occasionally use technology to supplement or reinforce instruction in my classroom, library, or lab	I use technology for basic skills with little or no connections with content objectives	I am aware that there are Technology Applications (TA) TEKS for Grades K-12 and adopted Technology Applications instructional materials	Up to 25% of my students have mastered Technology Applications TEKS	I have used a few web-based learning activities with my students
Developing Tech	I use technology to direct instruction, improve productivity, model technology skills, and direct students in the use of applications for technology integration My students use technology to communicate and present information	I have regular weekly access and use of technology and digital resources for curriculum activities in my classroom, library, or lab	I use technology to support content objectives	I am aware of the TA TEKS that are appropriate for content area TEKS and occasionally include technology skills in planning and implementing instruction I use adopted TA instructional materials to assist in instruction (where applicable)	26-50% of my students have mastered Technology Applications TEKS	I have customized several web-based lessons which include online TEKS-based content, resources, and learning activities that support learning objectives
Advanced Tech	I use technology in teacher-led as well as some student-centered learning experiences to develop higher order thinking skills and provide opportunities for collaboration with content experts, peers, parents, and community My students evaluate information, analyze data and content to solve problems	I have regular weekly access and use of technology and digital resources in various instructional settings such as in my classroom, library, lab, or through mobile technology	I use technology as a collaborative tool and integrate technology in subject area TEKS, to support development of higher-order thinking skills	I am knowledgeable of and consistently use Technology Applications (TA) TEKS as appropriate for content area and grade level	51 to 85% of my students have mastered Technology Applications TEKS	I have created many web-based lessons which include online TEKS-based content, resources, learning activities, and interactive communications that support learning objectives
Target Tech	My classroom is a student-centered learning environment where technology is seamlessly integrated to solve real world problems in collaboration with business, industry, and higher education Learning is transformed as my students propose, assess, and implement solutions to problems	My students and I have on-demand access to all appropriate technology and digital resources anytime/anywhere for technology integrated curriculum activities on the campus, in the district, at home, or key locations in the community	My students and I seamlessly apply technology across all subject areas to provide learning opportunities beyond the classroom that are not possible without the technology	I seamlessly integrate Technology Applications (TA) TEKS in collaborative, cross-curricular units of instruction	86 to 100% of my students have mastered Technology Applications TEKS	I have created and integrated web-based lessons which include online TEKS-based content, resources, learning activities, and interactive communications that support learning objectives throughout the curriculum
Campus STaR Chart Correlation	**Patterns of Classroom Use**	**Frequency/ Design of Instructional Setting Using Digital Content**	**Content Area Connections**	**Technology Applications (TA) TEKS Implementation** (TAC Chapter 126)	**Student Mastery of Technology Applications (TA) TEKS**	**Online Learning**

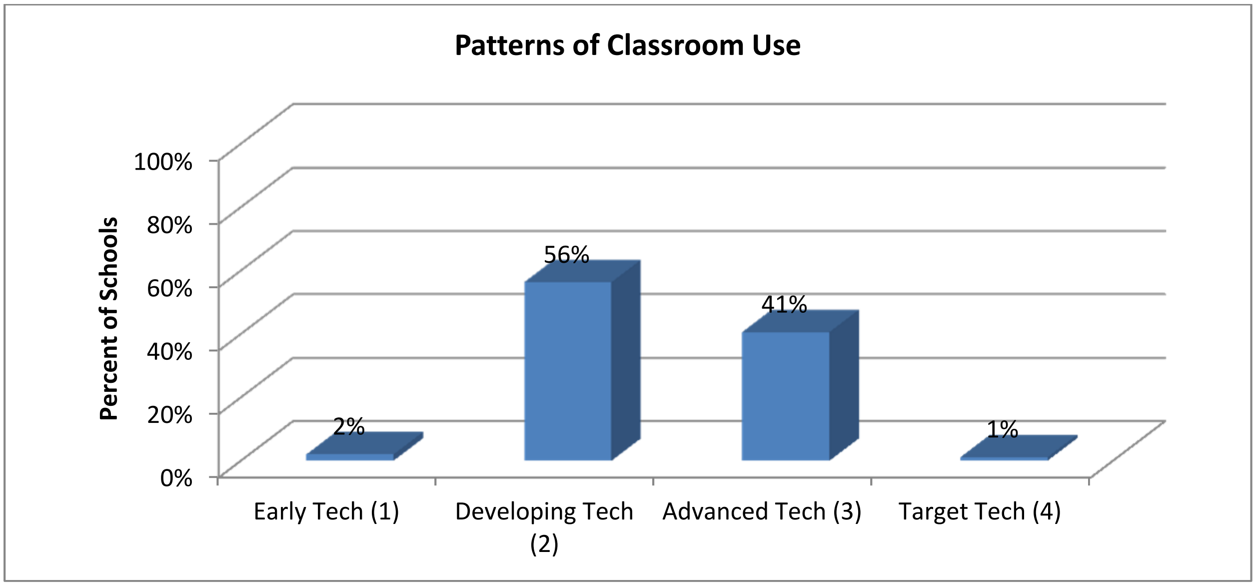
APPENDIX D

CHART USED BY TEACHERS TO COMPLETE THE STAR CHART

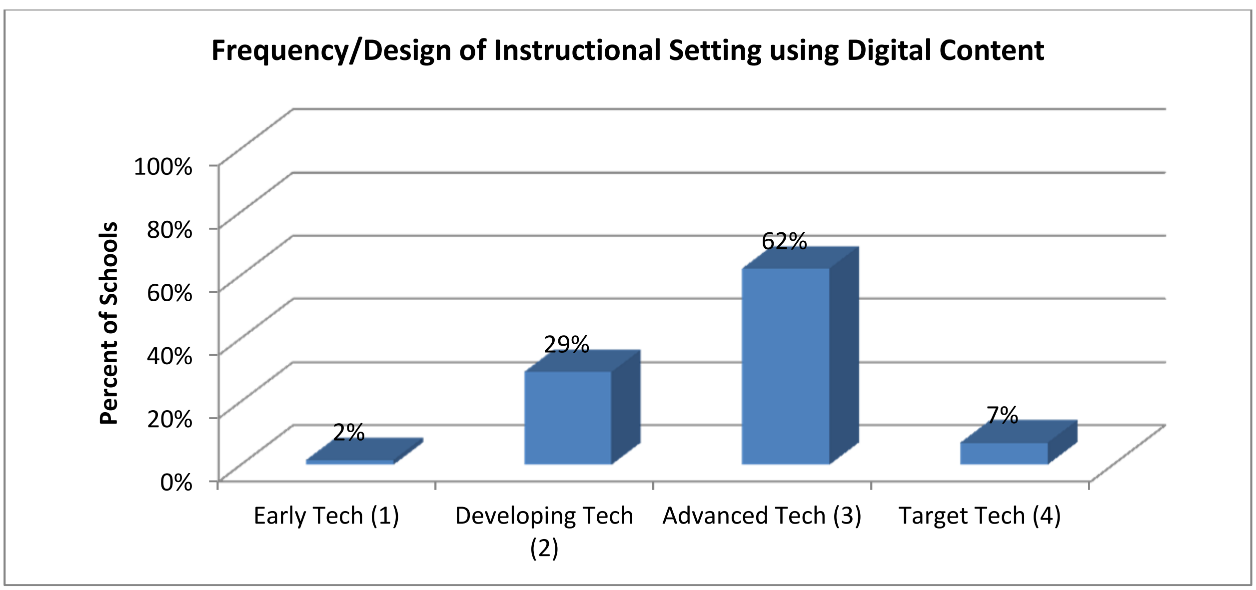
	Patterns of Classroom Use TL1	Frequency/ Design of Instructional Setting using Digital Content TL2	Content Area Connects TL3
Early Tech	I occasionally use technology to supplement instruction, streamline management functions, and present teacher-centered lectures. My students use software for skill reinforcement.	I occasionally use technology to supplement or reinforce instruction in my classroom, library, or lab	I use technology for basic skills with little or no connections with content objectives
Developing Tech	I use technology to direct instruction, improve productivity, model technology skills, and direct students in the use of applications for technology integration. My students use technology to communicate and present information.	I have regular weekly access and use of technology and digital resources for curriculum activities in my classroom, library, or lab	I use technology to support content objectives
Advanced Tech	I use technology in teacher-led as well as some student-centered learning experiences to develop higher order thinking skills and provide opportunities for collaboration with content experts, peers, parents, and community. My students evaluate information, analyze data and content to solve problems.	I have regular weekly access and use of technology and digital resources in various instructional settings such as in my classroom, library, lab, or through mobile technology	I use technology as a collaborative tool and integrate technology in subject area TEKS, to support development of higher-order thinking skills
Target Tech	My classroom is a student-centered learning environment where technology is seamlessly integrated to solve real world problems in collaboration with business, industry, and higher education. Learning is transformed as my students propose, assess, and implement solutions to problems.	My students and I have on-demand access to all appropriate technology and digital resources anytime/anywhere for technology integrated curriculum activities on the campus, in the district, at home, or key locations in the community	My students and I seamlessly apply technology across all subject areas to provide learning opportunities beyond the classroom that are not possible without the technology

APPENDIX E

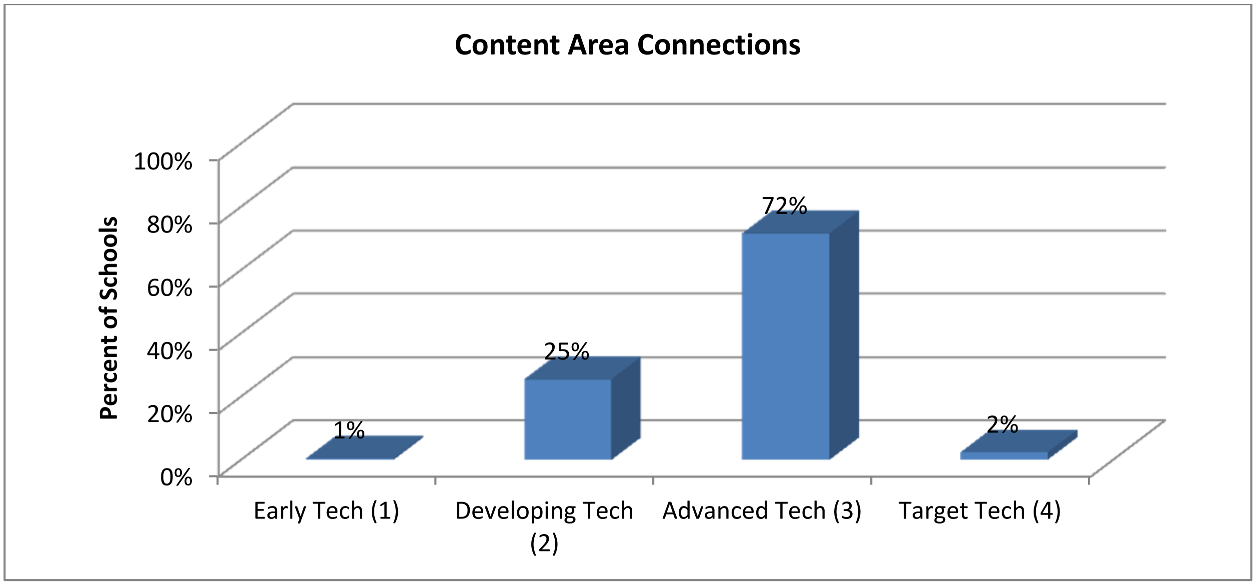
ADDITIONAL CHARTS AND FIGURES



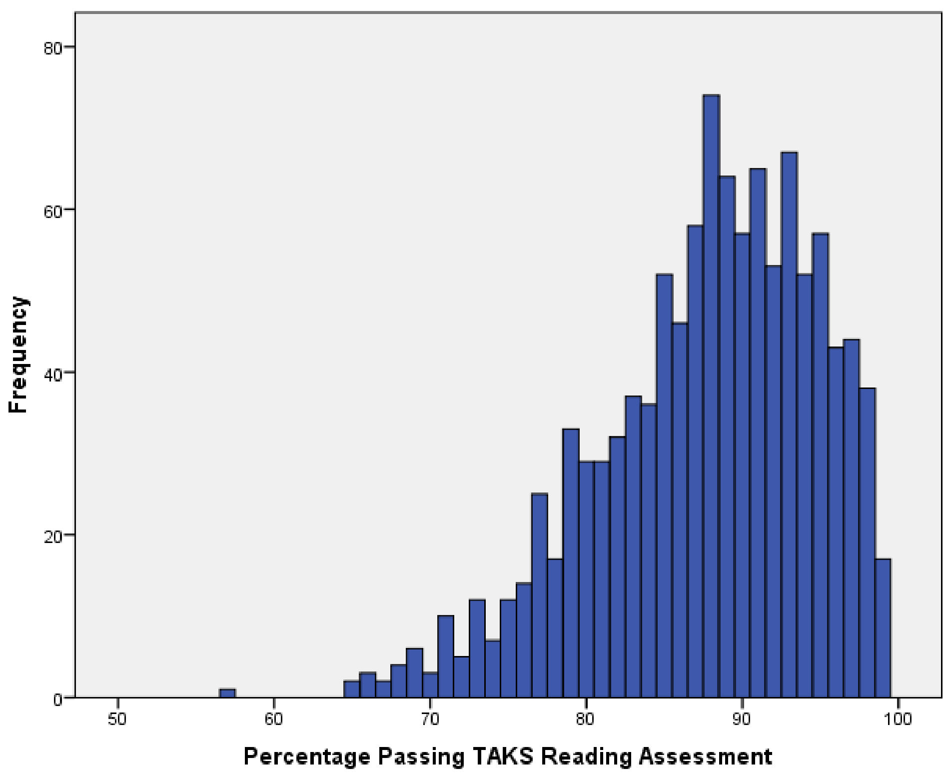
Distribution of ratings for STaR Chart, Patterns of Classroom Use (TL1)



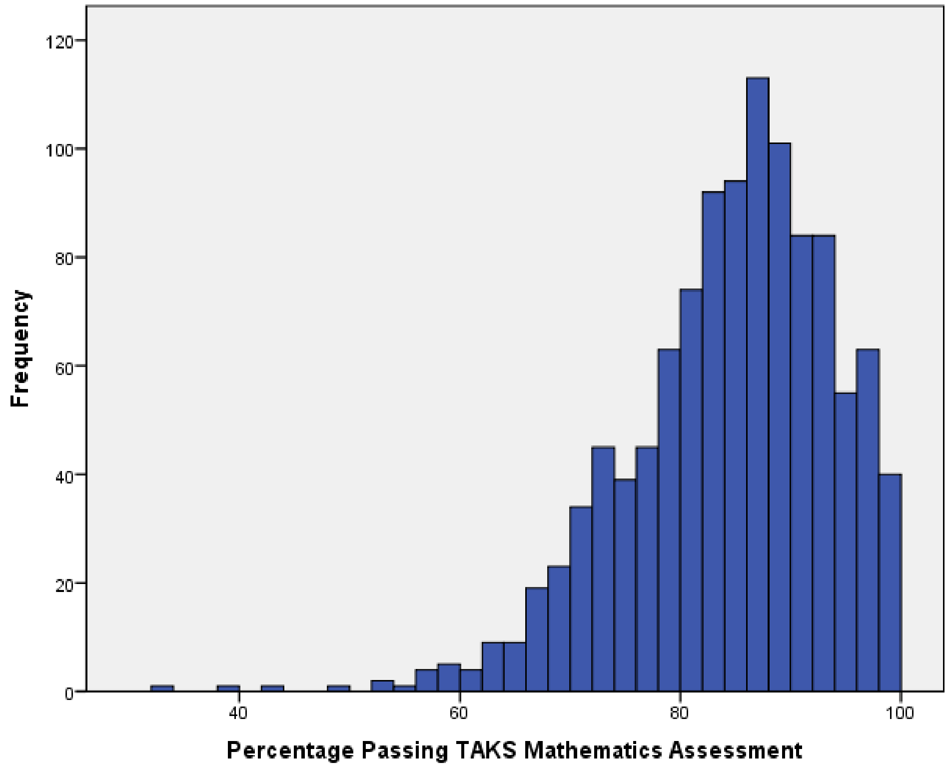
Distribution of ratings for STaR Chart, Frequency/Design of Instructional Setting using Digital Content (TL2)



Distribution of ratings for STaR Chart, Content Area Connections (TL3)



Distribution histogram for Reading achievement percentage passing scores



Distribution histogram for Mathematics achievement percentage passing scores